C. COHO SALMON

C.1 BACKGROUND AND HISTORY OF LISTINGS

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Coho salmon (*Oncorhynchus kisutch*) is a widespread species of Pacific salmon, occurring in most major river basins around the Pacific Rim from Monterey Bay in California north to Point Hope, AK, through the Aleutians, and from Anadyr River south to Korea and northern Hokkaido, Japan (Laufle et al. 1986). From central British Columbia south, the vast majority of coho salmon adults are 3-year-olds, having spent approximately 18 months in freshwater and 18 months in saltwater (Gilbert 1912, Pritchard 1940, Sandercock 1991). The primary exceptions to this pattern are "jacks," sexually mature males that return to freshwater to spawn after only 5-7 months in the ocean. However, in southeast and central Alaska, the majority of coho salmon adults are 4-year-olds, having spent an additional year in freshwater before going to sea (Godfrey et al. 1975, Crone and Bond 1976). The transition zone between predominantly 3-year-old and 4-year-old adults occurs somewhere between central British Columbia and southeast Alaska.

With the exception of spawning habitat, which consists of small streams with stable gravels, summer and winter freshwater habitats most preferred by coho salmon consist of quiet areas with low flow, such as backwater pools, beaver ponds, dam pools, and side channels (Reeves et al. 1989). Habitats used during winter generally have greater water depth than those used in summer, and also have greater amounts of large woody debris. West Coast coho smolts typically leave freshwater in the spring (April to June) and re-enter freshwater when sexually mature from September to November and spawn from November to December and occasionally into January (Sandercock 1991). Stocks from British Columbia, Washington, and the Columbia River often have very early (entering rivers in July or August) or late (spawning into March) runs in addition to "normally" timed runs.

Status reviews

The status of coho salmon for purposes of ESA listings has been reviewed many times, beginning in 1990. The first two reviews occurred in response to petitions to list coho salmon in the Lower Columbia River and Scott and Waddell creeks (central California) under the ESA. The conclusions of these reviews were that NMFS could not identify any populations that warranted protection under the ESA in the LCR (Johnson et al. 1991, *FR* 56(124):29553), and that Scott and Waddell creeks' populations were part of a larger, undescribed ESU (Bryant 1994, *FR* 59(80):21744).

A review of West Coast (Washington, Oregon, and California) coho salmon populations began in 1993 in response to several petitions to list numerous coho salmon populations and NMFS' own initiative to conduct a coastwide status review of the species. This coastwide review identified six coho salmon ESUs, of which the three southern most were proposed for listing, two were candidates for listing, and one was deemed "not warranted" for listing

(Weitkamp et al. 1995, *FR* 60(142): 38011). In October 1996, the BRT updated the status review for the Central California (CC) ESU, and concluded that it was at risk of extinction (NMFS 1996a). In October 1996, NMFS listed this ESU as threatened (*FR* 61(212): 56138).

In December 1996, the BRT updated the status review update for both proposed and candidate coho salmon ESUs (NMFS 1996b). However, because of the scale of the review, comanagers' requests for additional time to comment on the preliminary conclusions, and NMFS' legal obligations, the status review was finalized for proposed coho salmon ESUs in 1997 (NMFS 1997), but not for candidate ESUs. In May 1997, NMFS listed the Southern Oregon/Northern California coasts (SONCC) ESU as threatened, while it announced that listing of the Oregon Coast (OC) ESU was not warranted due to measures in the OCSRI plan (*FR* 62(87): 24588). This finding for OC coho salmon was overturned in August 1998, and the ESU listed as threatened (*FR* 63(153): 42587).

The process of updating the coho salmon status review was begun again in October 1998 for coho salmon in Washington and the lower Columbia River. However, this effort was terminated before the BRT could meet, due to competing activities with higher priorities.

In response to a petition by (Oregon Trout et al. 2000), the status of Lower Columbia River (LCR) coho salmon was revisited in 2000, with BRT meetings held in March and May 2001 (NMFS 2001a). The BRT concluded that splitting the LCR/Southwest Washington coast ESU to form separate LCR and Southwest Washington coast coho salmon ESUs was most consistent with available information and the LCR ESU was at risk of extinction. Like the 1996 status review update, these results were never finalized.

The coho salmon BRT[1] met in January, March and April 2003 to discuss new data received and to determine if the new information warranted any modification of the conclusions of the original BRTs. This report summarizes new information and the preliminary BRT conclusions on the following ESUs: Lower Columbia River, Oregon Coast, Southern Oregon/Northern California coasts, and Central California coast.

[1] The biological review team (BRT) for the updated status review for West Coast coho salmon included: Dr. Robert Iwamoto, Dr. Orlay Johnson, Dr. Pete Lawson, Gene Matthews, Dr. Paul McElhany, Dr. Thomas Wainwright, Dr. Robin Waples, Laurie Weitkamp, and Dr. John Williams, from NMFS Northwest Fisheries Science Center (NWFSC); Dr. Peter Adams, Dr. Eric Bjorkstedt, and Dr. Brian Spence from NMFS Southwest Fisheries Science Center (SWFSC); and Dr. Reginald Reisenbichler from the Northwest Biological Science Center, USGS Biological Resources Division, Seattle.

C.2.1 OREGON COASTAL COHO SALMON

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C.2.1.1 Summary of Previous BRT Conclusions

Major risk factors and status indicators

The Oregon Coastal Coho ESU has been assessed in two previous status reviews; one in 1995 (NMFS 1996a) and again in 1997 (NMFS 1997). In the 1995 status review (Weitkamp et al. 1995), the BRT considered evidence from many sources to identify ESU boundaries in coho populations from Washington to California. For the most part, evidence from physical environment, ocean conditions/upwelling patterns, marine and coded wire tag recovery patterns, coho salmon river entry and spawn timing as well as estuarine and freshwater fish and terrestrial vegetation distributions were the most informative to the ESU delineation process. Genetic information was utilized for an indication of reproductive isolation between populations and groups of populations. Based on this assessment, six ESUs were identified, including the Oregon Coast coho ESU, which includes naturally spawning populations in Oregon coastal streams north of Cape Blanco, to south of the Columbia River.

Evaluation of ESU under conditions in 1997

In 1997, there were extensive survey data available for coho salmon in this region. Overall, spawning escapements had declined substantially during the century, and may have been at less than 5% of their abundance in the early 1900s. Average spawner abundance had been relatively constant since the late 1970s, but pre-harvest abundance had declined. Average recruits-per-spawner may also have declined. Coho salmon populations in most major rivers appeared to have had heavy hatchery influence, but some tributaries may have been sustaining native stocks.

For this ESU, information on trends and abundance were better than for the more southerly ESUs. Main uncertainties in the assessment included the extent of straying of hatchery fish, the influence of such straying on natural population trends and sustainability, the condition of freshwater habitat, and the influence of ocean conditions on population sustainability. Total average (5-year geometric mean) spawner abundance for this ESU in 1996 was estimated at about 52,000. Corresponding ocean run size for the same year was estimated to be about 72,000; this corresponds to less than one-tenth of ocean run sizes estimated in the late 1800s and early 1900s, and only about one-third of those in the 1950s (ODFW 1995a). Total freshwater habitat production capacity for this ESU was estimated to correspond to ocean run sizes between 141,000 under poor ocean conditions and 924,000 under good ocean conditions (OCSRI Science Team 1996b). Abundance was unevenly distributed within the ESU at this time, with the largest total escapement in the relatively small Mid/South Coast Gene Conservation Group (GCG), and lower numbers in the North/Mid Coast and Umpqua GCGs.

Trend estimates using data through 1996 showed that for all three measures (escapement, run size, and recruits-per-spawner), long-term trend estimates were negative. More recent escapement trend estimates were positive for the Umpqua and Mid/South Coast Monitoring Areas, but negative in the North/Mid Coast. Recent trend estimates for recruitment and recruits-per-spawner were negative in all three areas, and exceed 12% annual decline in the two northern areas. Six years of stratified random survey (SRS) population estimates showed an increase in escapement and decrease in recruitment.

To put these data in a longer term perspective, ESU-wide averages in 1996 that were based on peak index and area under the curve (AUC) escapement indices, showed an increase in spawners up to levels of the mid-to-late 1980s, but much more moderate increases in recruitment. Recruitment remained only a small fraction of average levels in the 1970s. An examination of return ratios showed that spawner-to-spawner ratios had remained above replacement since the 1990 broodyear as a result of higher productivity of the 1990 broodyear and sharp reductions in harvest for the subsequent broods. As of 1996, recruit-to-spawner ratios for the 1991-1994 broods were the lowest on record, except for 1988 and, possibly, 1984. The 1997 BRT considered risk of extinction for this ESU under two scenarios: first, if present conditions and existing management continued into the foreseeable future and, second, if certain aspects of the Oregon Coastal Salmon Restoration Initiative (OCSRI) Draft Conservation Plan (Oregon Plan 1997) relating to harvest and hatchery production were implemented. The OCSRI is now (2003) called The Oregon Plan for Salmon and Watersheds.

Population abundance

Between the 1995 and 1997 status reviews, escapement increased for the ESU as a whole, but recruitment and recruits per spawner remained a small fraction of historical abundance. Spawning was distributed over a relatively large number of basins, both large and small. Natural escapement from 1990-1996 was estimated to be on the order of 50,000 fish per year in this ESU, reaching nearly 80,000 fish in 1996 coincident with drastic reductions in harvest. Pre-fishery recruitment was higher in 1996 than in either 1994 or 1995, but exhibited a fairly flat trend since 1990. The 1996 estimate of ESU-wide escapement indicated an approximately four-fold increase since 1990. When looked at on a finer geographic scale, the northern Oregon coast as of 1996, still had very poor escapement, the north/central coast showed mixed escapement with strong increases in some streams but continued very poor escapement in others, and the south/central coast continued to have increasing escapement.

Both recruitment and recruits-per-spawner had declined rapidly (12% to 20% annual declines from 1986 to 1996) in two of the three ODFW GCGs in this ESU. These declines were steeper and more widespread in this ESU than in any other coho salmon ESU for which data are available, and recruits-per-spawner continued to decline since this ESU was reviewed in 1994. The new data from 1994 to 1996 do not change the overall pattern of decline coupled with peaks in recruits-per-spawner every 4-5 years, with the height of the peaks declining through time.

Risks that this decline in recruits-per-spawner posed to sustainability of natural populations, in combination with strong sensitivity to unpredictable ocean conditions, was the most serious concern identified in 1997 by the BRT for this ESU. Some aspects of this concern were addressed by examining results of the viability models, although none of them incorporated declining recruits per spawner except as a consequence of changing ocean conditions. Preliminary results of viability models provided a wide range of results, with one model suggesting that most Oregon coastal stocks could not sustain themselves at ocean survivals that have been observed in the last 5 years, even in the absence of harvest, and another suggesting that stocks are highly resilient and would be at significant risk of extinction only if habitat degradation continues into the future. Consequently, a major question in evaluating extinction risk for this ESU was whether recent ocean and freshwater conditions would continue into the future.

Population trends and production

For this ESU, fishery recruitment forecasts for 1997 were slightly below the actual 1996 recruitment (PFMC 1997), and actual returns were drastically lower; about 25% of 1996 recruitment and the second lowest on record after 1977. Stream production studies conducted by ODFW (Solazzi and Johnson 1996) indicated that 1996 smolt production in four central coast study streams was lower than recent averages, with overwinter survival the lowest or second lowest on record for the two streams for which estimates were made, and that age-0 fish production was also low. They concluded that the "most significant impact was on juvenile coho salmon eggs that were in the gravel at the time of the [1995-96] flood." While these results were based on a small sample of streams and may not reflect average effects of the flood, they suggested that 1997 and 1998 adult returns to some coastal basins would be reduced by the floods. Longer term effects of the floods can also be expected to vary among basins, but most reports available to us suggest that long-term effects should generally be neutral or slightly beneficial (e.g. from sediment removal and increased off-channel habitat) to coho salmon.

Hatchery production and genetic risks

Widespread spawning by hatchery fish as indicated by scale data was also a major concern to the BRT. Scale analysis to determine hatchery-wild ratios of naturally spawning fish indicate moderate to high levels of hatchery fish spawning naturally in many basins on the Oregon coast, and at least a few hatchery fish were identified in almost every basin examined. Although it is possible that these data do not provide a representative picture of the extent of this problem, they represented the best information available at the time. In addition to concerns for genetic and ecological interactions with wild fish, these data also suggest natural spawner abundance may have been overestimated by ODFW and that the declines in recruits-per-spawner in many areas may have been even more alarming than current estimates indicate. However, by 1997 Oregon had made some significant changes in its hatchery practices, such as substantially reducing coho production levels in some basins, switching to on-station smolt releases, and minimizing fry releases. Uncertainty regarding the true extent of hatchery influence on natural populations, however, was a strong concern.

Another concern discussed by the BRT in 1997 was the asymmetry in the distribution of natural spawning in this ESU, with a large fraction of the fish occurring in the southern portion and relatively few in northern drainages. Northern populations were also relatively worse off by almost every other measure: steeper declines in abundance and recruits-per-spawner, higher proportion of naturally spawning hatchery fish, and more extensive habitat degradation.

Habitat conditions

With respect to habitat, the BRT had two primary concerns: first, that the habitat capacity for coho salmon within this ESU has significantly decreased from historical levels; and second, that the Nickelson and Lawson (1998) model predicted that, during poor ocean survival, only high quality habitat is capable of sustaining coho populations, and subpopulations dependent on medium and low quality habitats would be likely to go extinct. Both of these concerns caused the BRT to consider risks from habitat loss and degradation to be relatively high for this ESU.

Influence of OCSRI

The 1997 BRT considered only two sets of measures from the OCSRI: harvest management reforms and hatchery management reforms. The BRT did not consider the likelihood that these measures would be implemented; rather, it only considered the implications for ESU status if these measures were fully implemented as described. In order to carry out these evaluations, the BRT made the following assumptions:

1) The ocean harvest management regime would be continued as proposed into the foreseeable future, not revised in the year 2000 as stated in the plan. Without this assumption, effects of the plan beyond 2000 could not be evaluated.

2) Hatchery releases would continue at or below 1997 release levels (including approximately 1 million annual fry releases) into the foreseeable future.

3) The goals of maintaining naturally-spawning hatchery fish at less than 10% or 50% of natural escapement (depending on genetic similarity with natural fish) would be achieved and demonstrated by effective monitoring.

Some members had a strong concern that we do not know enough about the causes of declines in run size and recruits per spawner to be able to directly assess the effectiveness of specific management measures.

Harvest measures

Some members of the BRT felt that the harvest measures were the most encouraging part of the plan, representing a major change from previous management. However, there was concern that the harvest plan might be seriously weakened when it was re-evaluated in the year 2000, concern that combining the Umpqua and south/central coast GCGs into a larger aggregate (as would occur in the proposed harvest plan) might not adequately protect genetic diversity, and concern about our ability to effectively monitor non-target harvest mortality and to control overall harvest impacts.

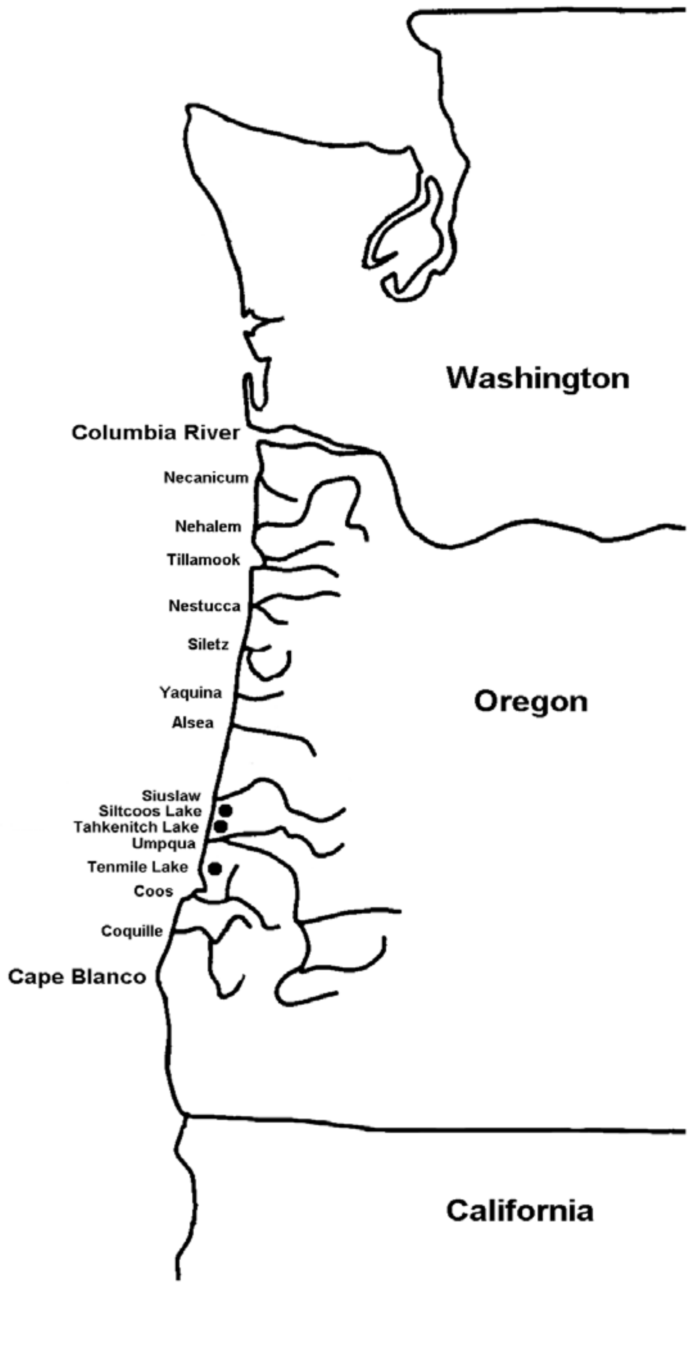
Hatchery measures

Of the proposed hatchery measures, substantial reductions in smolt releases were thought to have the most predictable benefit for natural populations; all else being equal, fewer fish released should result in fewer genetic and ecological interactions with natural fish. Marking all hatchery fish should also help to resolve present uncertainties about the magnitude of these interactions. However, the BRT expressed concerns regarding some aspects of the proposed hatchery measures. The plan was vague on several key areas, including plans for incorporation of wild broodstock and how production would be distributed among facilities after 1997. One concern was that the recent and proposed reductions appear be largely motivated by economic constraints and the present inability to harvest fish if they were produced rather than by recognition of negative effects of stray hatchery fish on wild populations. Other concerns expressed by the BRT included no reductions in fry releases in many basins, substantially higher releases of smolts in the Yaquina River Basin (which by ODFW's own assessment has more high quality habitat than any other coastal basin), and no consideration of alternative culture methods that could be used to produce higher-quality hatchery smolts which may have less impact on wild fish. Another concern was the plan's lack of recognition that hatchery-wild interactions reduce genetic diversity among populations.

Previous BRT Conclusions

In 1997, the BRT concluded that, assuming that 1997 conditions continued into the future (and that proposed harvest and hatchery reforms were not implemented), this ESU was not at significant short-term risk of extinction, but that it was likely to become endangered in the foreseeable future. A minority felt that the ESU was not likely to become endangered. Of those members who concluded that this ESU was likely to become endangered, several expressed the opinion that it was near the border between this and a "not at risk" category. The BRT generally agreed that implementation of the harvest and hatchery proposals of the OCSRI would have a positive effect on the status of the ESU, but the BRT was about evenly split as to whether the effects would be substantial enough to move the ESU out of the "likely to become endangered" category. Some members felt that, in addition to the extinction buffer provided by the estimated 80,000 naturally produced spawners in 1996, the proposed reforms would promote higher escapements and alleviate genetic concerns so that the ESU would not be at significant risk of extinction or endangerment. Other members saw little reason to expect that the hatchery and harvest reforms by themselves would be effective in reducing what they viewed as the most serious threat to this ESU—declining recruits-per-spawner. If the severe declines in recruits-per-spawner of natural populations in this ESU were partly a reflection of continuing habitat degradation, then risks to this ESU might remain high even with full implementation of the hatchery and harvest reforms. While harvest and hatchery reforms may substantially reduce short-term risk of extinction, habitat protection and restoration were viewed as key to ensuring long-term survival of the ESU, especially under variable and unpredictable future climate conditions. The BRT therefore concluded that these measures would not be sufficient to alter the previous conclusion that the ESU is likely to become endangered in the foreseeable future.

Figure C.2.1.1. Map of Oregon and Washington coasts showing the 11 major river systems plus three coastal lakes that comprise the Oregon Coast Coho Salmon ESU



Listing status

The Oregon Coast ESU of coho salmon was listed as a Threatened Species on August 10, 1998. The ESU includes all naturally spawned populations of coho salmon in Oregon Coastal Streams south of the Columbia River and north of Cape Blanco (Figure C.2.1.1).

C.2.1.2 New Comments

Alsea Valley Alliance v. Evans

On 10 September 2001 Judge Michael R. Hogan, ruling in *Alsea Valley Alliance v. Evans* for the United States District Court for the District of Oregon, found that, for the Oregon Coast ESU, "NMFS's listing decision is arbitrary and capricious, because the Oregon Coast ESU includes both "hatchery spawned" and "naturally spawned" coho salmon, but the agency's listing decision arbitrarily excludes "hatchery spawned" coho. Consequently, the listing is unlawful." (161 F. Supp. 2d 1154, D. Oreg. 2001). The lawsuit was brought by the Alsea Alliance, partly in response to an action by ODFW to terminate a domesticated coho salmon broodstock at the Fall River Hatchery on the Alsea River.

The effect of the ruling was to delist the Oregon Coast ESU. An appeal by appellant intervenors in the *Alsea* case is pending before the U.S. Court of Appeals for the Ninth Circuit. On December 14, 2001 the Court stayed the District Court ruling pending final disposition of the appeal (*Alsea Valley Alliance v. Evans*, 9th Circuit appeal, No. 01-36071, December 14, 2001). This returned the status of the Oregon Coast ESU to "threatened" under the Endangered Species Act. NMFS is currently reviewing its listing policy with regard to hatchery and wild salmon.

Petition for listing

On 25 April 2002 Regional Administrator D. Robert Lohn received a petition to define and list the wild stocks of coho along the Oregon Coast as a threatened species, pursuant to the Endangered Species Act, 16, U.S.C. Sec. 1531 et seq. (2001) (ESA). The petitioners present recent scientific reports relating to the "behavioral, physiological, ecological, reproductive and evolutionary differences between the hatchery and wild stocks" of Oregon coast coho salmon. The petition was in response to the findings of *Alsea Valley Alliance v. Evans*. The petitioners consist of Trout Unlimited, Oregon Council of Trout Unlimited, Washington Council of Trout Unlimited, Oregon Trout, Washington Trout, Native Fish Society, Oregon Council of Fly Fishers, Pacific Coast Federation of Fisherman's Associations and the Institute for Fisheries Resources, Oregon Natural Resources Council, Save our Wild Salmon, Orange Ribbon Foundation, American Rivers, Audubon Society of Portland, National Wildlife Federation, and the Siskiyou Regional Education Project. The petitioners state that:

> "NMFS has previously made findings of the detrimental impact that the artificial production of Oregon coast coho have on wild stocks, including genetic impacts, disease transmission, predation, take for broodstock purposes, and competition (62 Fed. Reg. 24588, 24600 (NMFS 1997); Flagg et al. 2000). Furthermore, recent reports indicate that these impacts are not localized, but rather widespread in every basin in the Oregon coast where wild coho are present, based on the presence of hatchery coho in every stream system (ODFW 1995b; Jacobs et al 2001). Additionally, the fluctuations in the ocean conditions, and the changes in the ocean carrying capacity, may exacerbate the impacts in certain years (NWPPC 1999). Additional reports suggest that the

impact of these hatchery programs is resulting in at least phenotypic differences (genetic and environmental) between coho, and is not limited to hatchery management practices alone, but due to other direct biological and environmental effects (IMST 2001; Flagg et al. 2000; Chilcote 2002)."

The petitioners cite substantial updated information on current abundance, historical abundance and carrying capacity, trends in abundance, natural and human influenced factors that cause variability in survival and abundance, possible threats to genetic integrity, and recent events such as the current El Niño, significant flood events in 1995-96 and 1998, and recently improved ocean conditions (Trout Unlimited 2002).

Independent multidisciplinary science team

Since the 1997 status review, the Oregon Plan for Salmon and Watersheds (formerly Oregon Coastal Salmon Restoration Initiative Conservation Plan) has developed into an extensive effort to recover threatened or endangered salmonid populations through a combination of grass-roots actions through watershed councils, refocusing effort and resources of fisheries and other state agencies, and convening a group of scientists to "advise the state on matters of science related to the Oregon Plan for Salmon and Watersheds" (IMST 2002b). This group of scientists consists of a seven-member team with "recognized expertise in fisheries artificial propagation, stream ecology, forestry, range, watershed and agricultural management" and is known as the Independent Multidisciplinary Science Team (IMST). The IMST has been responsible for a series of review documents on the science relating to recovery of Oregon coastal coho stocks. The first of these was a workshop of agency and university fisheries professionals convened to help in the discussion of "Defining and Evaluating Recovery of OCN Coho Salmon Stocks: Implications for Rebuilding Stocks under the Oregon Plan" (IMST 1999). Alternative recovery definitions are proposed and criteria for evaluating recovery are discussed.

Additional reports issued by this team germane to the deliberations of the Oregon coastal coho BRT include: "Conservation Hatcheries and Supplementation Strategies for Recovery of Wild Stocks of Salmonids: Report of a Workshop" (IMST 2000), and "The scientific basis for artificial propagation in the recovery of wild anadromous salmonids in Oregon" (IMST 2001), which analyzes the hatchery programs of ODFW, presents three substantial conclusions and puts forth a series of ten recommendations based on these conclusions. In addition, a comprehensive look at the "Recovery of Wild Salmonids in Western Oregon Lowlands" (IMST 2002a) provides an extensive analysis of five science questions relating to the importance of lowlands to the recovery of salmonids, with twenty-one recommendations relating to recommended actions by state agencies to contribute to the recovery of salmonids in lowland areas. They do not, however, present substantially new information that can shed light on the evaluation of risk to the Oregon coastal coho ESU.

Douglas County Board of Commissioners—The board submitted a report, "Viability of coho salmon populations on the Oregon and northern California coasts," submitted to NMFS Protected Resources Division on 12 April 2002 and prepared by S.P. Cramer and Associates, Inc. (Cramer and Ackerman 2002). This report analyzes information available for both the Oregon Coastal Coho Salmon ESU and the SONCC ESU in several areas: trends in abundance and distribution, trends in survival, freshwater habitat condition, potential hatchery-wild interactions, changes in harvest regulation, and extinction risk modeling. Few of the data presented in the report are new, but independent analyses focus on unique aspects of the data. They cite changes in fishery management, increasing spawning escapements, reduced hatchery releases, habitat restoration, and evidence of successful rearing of fry outmigrants throughout the Oregon Coast. While the report reached no conclusions regarding overall status of the ESU, the Board cites the report in concluding that coho salmon populations in this ESU are “strongly viable.”

C.2.1.3 New Data and Update Analyses

Population abundance

For the Oregon Coast ESU, the BRT has received updated estimates of total natural spawner abundance based on stratified random survey (SRS) techniques, broken down by ODFW's Monitoring Areas (MAs), for 11 major river basins, and for the coastal lakes system (Steve Jacobs, Oregon Department of Fish and Wildlife, 28655 Hwy 34, Corvallis, Oregon 97333, pers. commun. Nov. 14, 2002) (ODFW’s Monitoring Areas are similar, but not identical to, the GCGs that were the population units in the 1997 update). These data are for the return years 1990-2002 and are presented in Table C.2.1.1 (for consistency with the previous status review for this ESU abundance and trend analysis in this update are expressed in terms of naturally-produced fish rather than the standard of naturally spawning fish used in other status review updates). Total recent average (3-year geometric mean) spawner abundance for this ESU is estimated at about 140,600, up from 5-year geometric mean of 52,000 in the 1997 update and also higher than the estimate at the time of the status review. In 2001 the ocean run size was estimated to be about 178,000; this corresponds to one-tenth of ocean run sizes estimated in the late 1800s and early 1900s, and only about one-third of those in the 1950s (ODFW 1995a). In 2002 the ocean-run size increased to 304,500 – fourth highest since 1970 and perhaps 25% of historical abundance. Present abundance is more evenly distributed within the ESU than it was in 1997. Escapement in the relatively small Mid/South Coast MA had been the strongest in the ESU until 2001. In 2002 escapements in the Mid/South were down about 25% while the North and Mid Coast MAs showed strong gains. The Umpqua MA is up by a factor of 4 since 1996. (Table C.2.1.1).

We have updated ocean exploitation estimates based on: Oregon Productivity Index (OPI) estimated catch and escapement based on SRS methods (“OPI-SRS”) for 1970-1993, post-season results of the Coho Fishery Regulation Assessment Model (“FRAM”) for 1994-2001, and the pre-season FRAM estimate for 2002 (OPI-SRS and FRAM from PFMC 2002). The ODFW Standard Index spawner escapement estimates were discontinued in 1999 and data from 1970-1989 were standardized to the SRS data. All analyses were done using this updated time series. Exploitation rates are based on ocean catch and incidental mortality plus escapement. Recruits are calculated as spawners divided by 1 minus the ocean exploitation rate. A major assumption is that progeny of natural spawners are affected by fishing gear the same as hatchery fish, so that ocean mortalities are in the same proportion as escapement. Freshwater harvest and mortality is not directly assessed, but is conventionally considered to be 10% of ocean escapement for retention fisheries and 1% for catch and release fisheries. The BRT also did not attempt to adjust trends for the contribution of stray hatchery fish; sufficient data for such an adjustment are not available for these populations.

We determined that the coded-wire-tag-based index (CWT) has become less useful since the implementation of coho non-retention fisheries in 1994. The CWT index depends on ocean recoveries of coded-wire tags and there are no tag recoveries in non-retention fisheries. Non-catch mortalities (hook-and-release, drop-off, illegal retention) are either estimated in the coho FRAM or estimated externally and input directly in the model.

We used escapement estimates provided by ODFW (Table C.2.1.1) (Steve Jacobs, Oregon Department of Fish and Wildlife, 28655 Hwy 34, Corvallis, Oregon 97333, pers. commun. Nov. 14, 2002). The SRS escapement data indicate that, on an ESU-wide basis, spawning escapement reached a 30-year high in 2001 and continued to climb in 2002 (Figures C.2.1.2 and C.2.1.3). This high escapement is due to a combination of improved marine survival and sharply curtailed ocean fisheries. When looked at on a finer geographic scale, the North Coast has responded well after a very weak period through 1999. The Mid Coast was mixed in 2001 with strong increases in some streams but continued very poor escapement in others. Substantial increases in 2002 made it the strongest area on the coast. The Mid-South coast rebounded in 2002 after a 4-year drop (Table C.2.1.1).

Three-year statistics (geometric mean, arithmetic mean, minimum and maximum spawners and recruits) in individual river basins are strongly affected by the recent two years of high marine survival (Table C.2.1.2). Abundance has grown exponentially in the past three years, so Arithmetic means are uniformly higher than geometric means. The minimum and maximum abundances show that, with a few exceptions, abundances in individual basins have increased about 10-fold in the past three years. Abundance in the Nehalem ranged only from 14285 to 22310 indicating this system may have been near capacity before survival improved. On the other hand, the Yaquina grew from 647 to 25039 – nearly a 40-fold increase. Statistics for the combined systems (Table C.2.1.3) are more stable, but indicate an overall four-fold increase in spawners over the past three years.

Table C.2.1.1. Numbers of natural-origin spawners in the Oregon Coast Coho ESU estimated from ODFW Stratified Random Surveys, 1990—2002 return years. Results are sub-totaled by ODFW Monitoring Area, rivers, lakes, and coast-wide. Monitoring Area totals from 1999-2002 are estimated by Monitoring Area and may differ from the sums of the individual rivers.

Management Area:	Return Year												
Location	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
North Coast:													
Necanicum and Elk Creek	191	1,135	185	941	408	211	768	253	946	728	474	5,247	2,710
Nehalem	1,552	3,975	1,268	2,265	2,007	1,463	1,057	1,173	1,190	3,713	14,285	22,310	20,654
Tillamook Bay	265	3,000	261	860	652	289	661	388	271	2,175	1,983	1,883	16,488
Nestucca	189	728	684	401	313	1,811	519	271	169	2,201	1,171	3,940	12,334
Sand Lake and Neskowin Cr	0	240	24	41	77	108	275	61	0	47	0	71	16
Miscellaneous	0	204	0	0	0	0	0	0	0	0	0	0	0
North Coast Total	2,197	9,281	2,423	4,509	3,457	3,881	3,280	2,147	2,576	8,842	17,898	33,667	52,202
Mid-North:													
Salmon	385	39	28	364	107	212	271	237	8	175	0	310	1,237
Siletz	441	984	2,447	400	1,200	607	763	336	394	706	3,553	1,437	2,369
Yaquina	381	380	633	549	2,448	5,668	5,127	384	365	2,588	647	3,039	25,039
Beaver Creek	23	0	756	500	1,259	0	1,340	425	1,041	3,366	738	5,274	7,596
Alsea	1,189	1,561	7,029	1,071	1,279	681	1,637	680	213	2,050	2,465	3,339	5,767
Yachats	280	28	337	287	67	117	176	99	102	150	79	52	1,661
Siuslaw	2,685	3,740	3,440	4,428	3,205	6,089	7,625	668	1,089	2,724	6,767	11,024	57,125
Miscellaneous	207	0	700	180	251	231	1,188	13	71	0	12	764	3,315
Mid-North Total	5,592	6,732	15,371	7,779	9,815	13,605	18,127	2,843	3,283	11,442	14,181	25,528	104,111

Table C.2.1.1 (continued).

Umpqua:													
Lower Umpqua and Smith	589	1,316	1,759	4,804	1,689	6,803	4,904	935	5,118	2,323	3,696	8,850	25,939
Umpqua	455	0	192	1,431	1,240	352	339	397	444	1,289	2,774	8,177	7,972
Elk Creek and Calapooya Creek	185	0	0	0	708	2,315	1,709	196	379	434	1,864	2,581	1,477
South Umpqua	2,508	2,284	0	2,415	579	755	1,685	512	678	1,219	479	6,482	1,419
Cow Creek	0	0	201	661	269	1,124	1,112	193	1,807	1,234	1,582	6,661	5,608
Umpqua Total	3,737	3,600	2,152	9,311	4,485	11,348	9,749	2,233	8,426	6,466	10,468	34,041	42,413
Mid-South:													
Coos Bay and Big Creek	2,273	3,813	16,545	15,284	14,685	10,351	12,128	1,127	3,167	4,945	5,386	43,301	35,005
Coquille	2,712	5,651	2,115	7,384	5,035	2,116	16,169	5,720	2,466	3,001	6,130	13,310	8,488
Miscellaneous	0	1	2	3	4	5	6	7	8	9	10	11	11
Mid-SouthTotal	4,985	9,465	18,662	22,671	19,724	12,472	28,303	6,854	5,641	7,946	11,516	56,611	43,512
Coast-wide Rivers	16,512	29,078	38,607	44,270	37,481	41,306	59,459	14,076	19,926	34,696	54,063	149,847	242,238
Lakes	4,394	7,251	1,986	10,145	5,842	11,216	13,494	8,603	11,108	12,711	12,747	19,669	22,097
Coast-wide Total	20,906	36,329	40,593	54,415	43,323	52,522	72,953	22,679	31,034	47,407	66,810	169,516	264,335

Table C.2.1.2. Three-year statistics and 13-year trends for 11 major river basins in the Oregon Coast ESU. Spawners are natural-origin spawners only. Recruits are natural-origin adults before ocean harvest.

	Spawners						Recruits					
	3 year mean		3 year range		13 year		3 year mean		3 year range		13 year	
Basin	Geometric	Arithmetic	Minimum	Maximum	Trend	SE	Geometric	Arithmetic	Minimum	Maximum	Trend	SE
Necanicum	1889	2810	474	5247	1.169	0.860	2096	3,101	522	5,667	1.076	0.941
Nehalem	18741	19083	14285	22310	1.206	0.889	20799	21,188	15,728	24,097	1.110	1.042
Tillamook	3949	6785	1883	16488	1.191	1.084	4382	7,723	2,034	18,952	1.096	1.191
Nestucca	3846	5815	1171	12334	1.230	1.015	4269	6,574	1,289	14,177	1.132	1.133
Siletz	2295	2453	1437	3553	1.070	0.760	2547	2,729	1,552	3,912	0.985	0.847
Yaquina	3665	9575	647	25039	1.204	1.205	4067	10,925	712	28,780	1.108	1.204
Alsea	3621	3857	2465	5767	1.042	0.960	4018	4,316	2,714	6,629	0.959	1.089
Siuslaw	16213	24972	6767	57125	1.120	1.037	17993	28,339	7,450	65,661	1.031	1.150
Umpqua	24351	28520	10395	42415	1.182	0.662	27025	31,857	11,445	48,753	1.088	0.764
Coos	20136	27897	5386	43301	1.088	1.066	22346	30,978	5,930	46,769	1.002	1.098
Coquille	8847	9309	6130	13310	1.070	0.649	9819	10,294	6,749	14,376	0.984	0.684

Table C.2.1.3. Three-year statistics and 33-year trends for Oregon Coast ESU rivers, lakes, and combined rivers and lakes. Spawners are natural-origin spawners only. Recruits are natural-origin adults before ocean harvest.

	Spawners						Recruits					
	3 year mean		3 year range		33 year		3 year mean		3 year range		33 year	
	Geometric	Arithmetic	Minimum	Maximum	Minimum	Maximum	Geometric	Arithmetic	Minimum	Maximum	Trend	SE
Rivers	122718	147933	50500	242200	1.017	0.600	136291	165933	55600	279000	0.950	0.575
Lakes	16189	16635	12747	22097	1.013	0.735	17966	18567	14034	25399	0.946	0.592
Combined	140568	164569	63247	264297	1.016	0.566	156105	184500	69634	304399	0.949	0.520

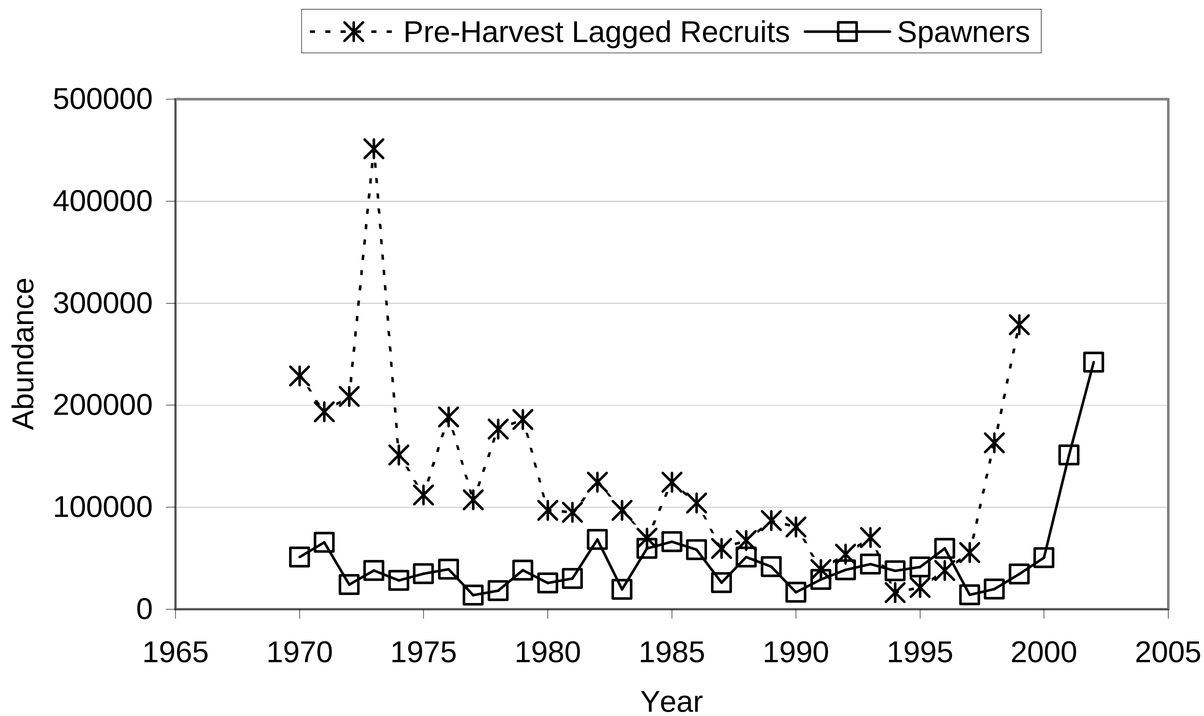


Figure C.2.1.2. Time series of spawners and pre-harvest recruits, by broodyear, for rivers in the Oregon Coast coho salmon ESU.

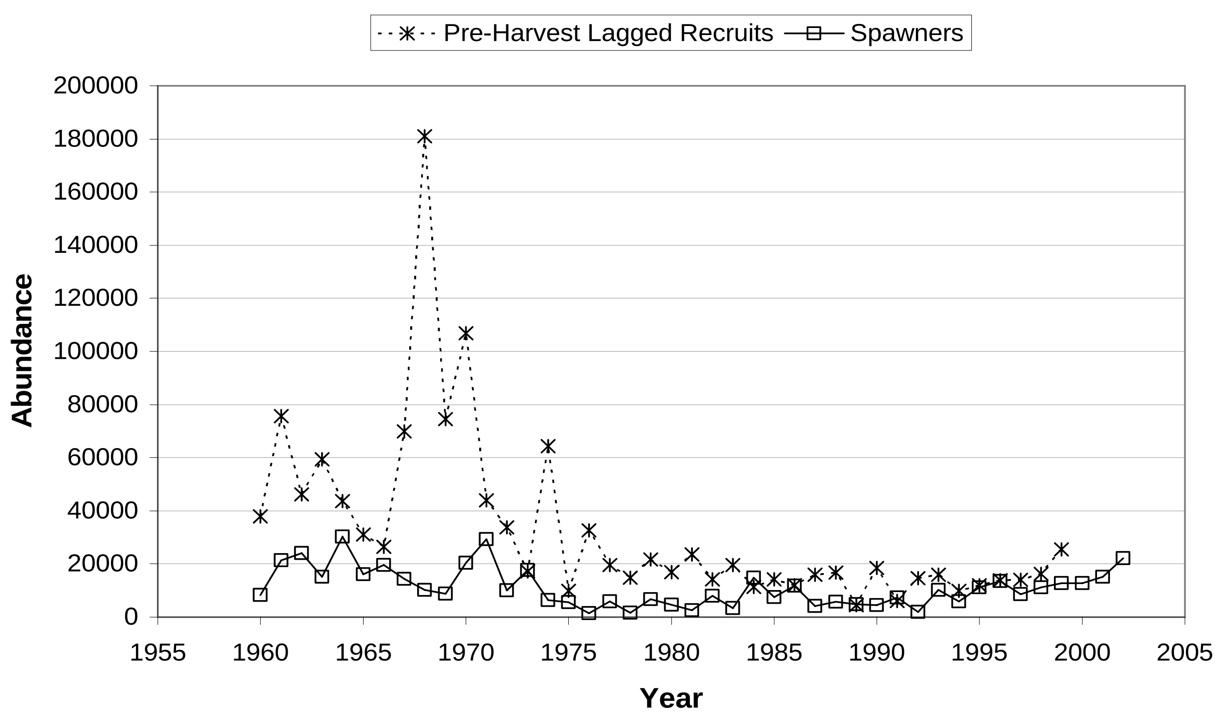


Figure C.2.1.3. Time series of spawners and pre-harvest recruits, by broodyear, for lakes in the Oregon Coast coho salmon ESU.

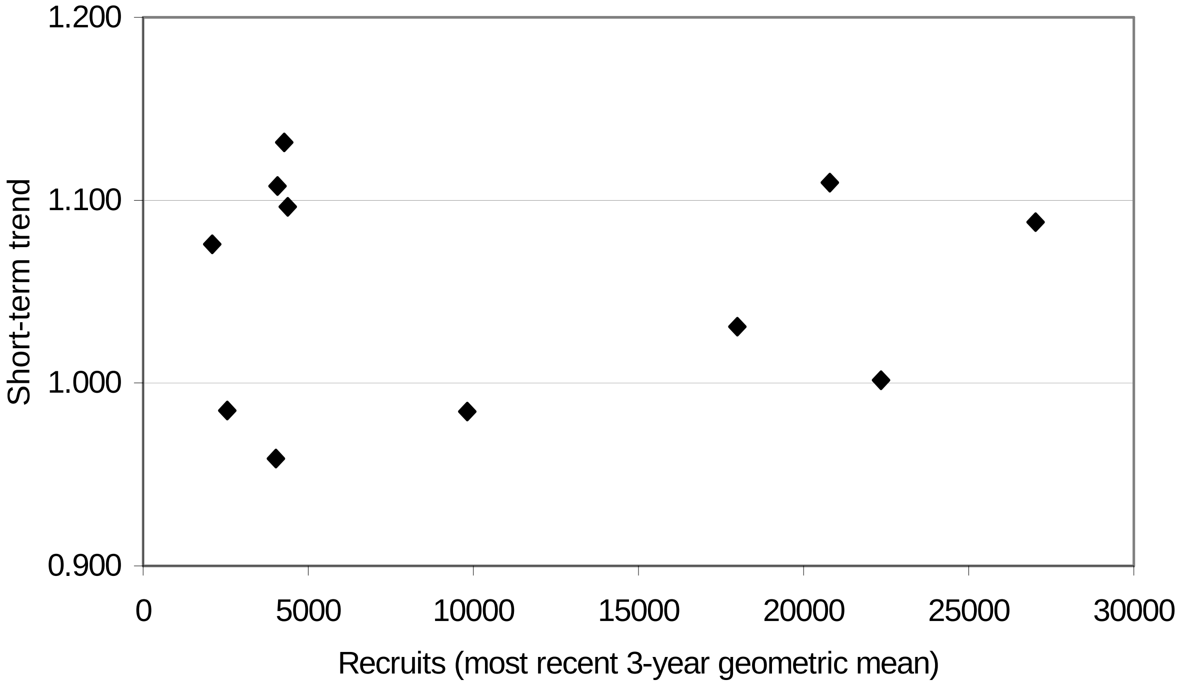


Figure C.2.1.4. Short-term (13-year, 1990-2002) trends in spawners and recruits vs. the recent 3-year geometric mean abundance plotted for 11 major river populations.

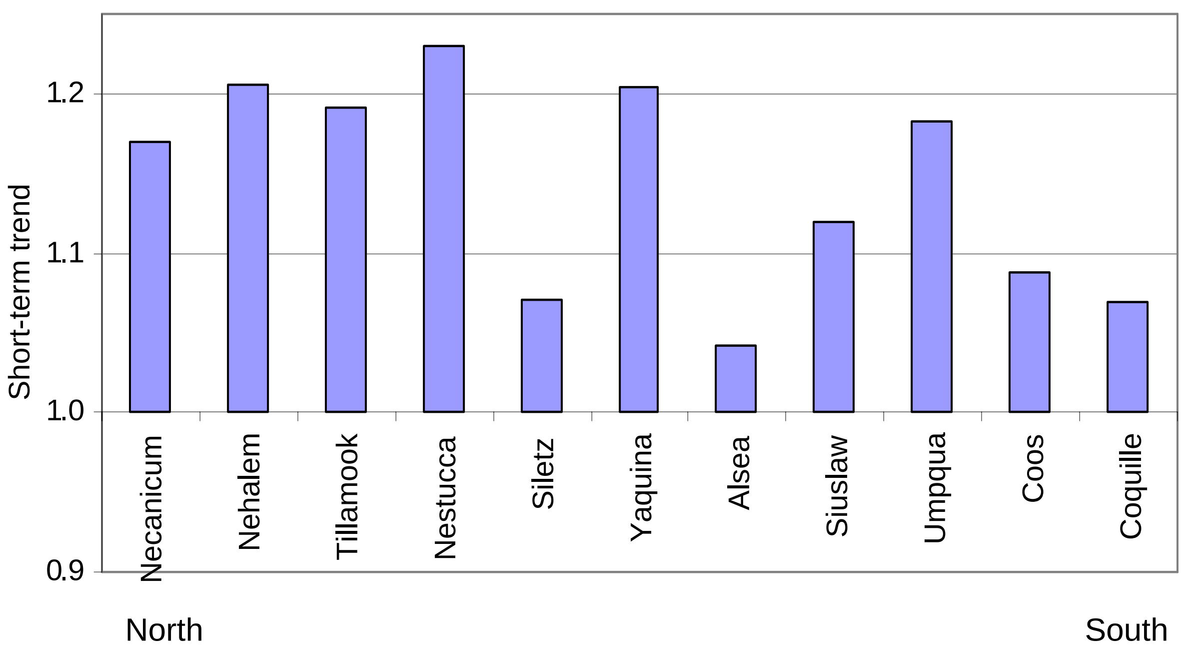


Figure C.2.1.5. Short-term (13-year, 1990-2002) trends in spawner abundance for 11 major river basins in the Oregon Coast coho salmon ESU. Basins are ordered from north to south.

In the return years 1997-1999 (broodyears 1994-1996), and for the first time on record (since 1950), recruits failed to replace the parental spawners: a recruitment failure occurred in all three brood cycles, even before accounting for harvest-related mortalities (Figure C.2.1.2). Since 1999, improving marine survival and higher rainfall are thought to be the factors contributing to an upswing in wild recruitment. Fishery recruitment for 2002 was up over four-fold from 2000 with about 304,000 recruits, but below the 30-year high of 450,000 observed in 1973. Given current habitat conditions OCN coho are thought to require an overall marine survival rate of 0.03 to achieve a spawner:recruit ratio of 1:1 in the best quality habitat (Nickelson and Lawson 1998). Less productive habitats require higher marine survivals to sustain populations. Based on OPI hatchery survival rates marine survival after exploitation exceeded 0.03 only in the year 2001. Assuming natural spawners survive at twice the hatchery rate there were seven of thirteen years since 1990 with marine survivals after exploitation high enough to sustain the strongest populations. Increases in recruits and spawners (Figures C.2.1.2 and C.2.1.3) reflect improved marine survival for the 2000 and 2001 smolt years. It is far from certain that these favorable marine conditions will continue and, with the current freshwater habitat conditions, the ability of OCN coho to survive another prolonged period of poor marine survival remains in doubt.

Growth rates/productivity

Trend analyses were performed on short-term and long-term time series of spawner abundance and pre-harvest recruit abundance calculated as described above. Short-term trends were based on stratified-random-sampling (SRS) estimates of abundance in 11 major river basins considered to be the principal populations in this ESU. Short-term trends used data from 1990-2002 return years. Long-term trends were estimated separately for the aggregated coastal rivers (including several small systems outside the 11 major river basins) and for the coastal lakes. The river trends were based on data calibrated to the SRS time series from 1970-2002. The lake trends were based on the historical time series of lakes abundance from 1970-2002.

Thirteen-year trends of spawner abundance for 11 major river systems are presented in Table 2.1.2 and illustrated in Figures C.2.1.4 and C.2.1.5. Spawner trends have been positive in all 11 basins, with the biggest increases (> 10% per year) on the north coast (Necanicum, Nehalem, Tillamook, Nestucca), mid-coast (Yaquina, Siuslaw) and the Umpqua, and with smaller increases on the central (Siletz, Siuslaw) and south (Coos, Coquille) coast. The Alsea showed the weakest trend and was > 1 as of the 2002 spawning returns (Figure C.2.1.5).

Thirteen-year trends in pre-harvest recruits (Figures C.2.1.4 and C.2.1.6) show a less favorable picture. Necanicum, Nehalem, Tillamook, Nestucca, Yaquina, and Umpqua all showed positive trends of about 8 -13% per year. Siletz, Alsea, and Coquille showed declines ranging of 1 - 4% per year. Upward trends in the Tillamook, Siuslaw, and Coos hinge on the high 2002 escapements. The most recent 3-year geometric mean abundance showed little relationship to trend (Figure C.2.1.4).

Long-term (33-year) trends in spawner abundance for both the lakes and rivers have been relatively flat (Table C.2.1.3, Figure C.2.1.7), with lakes increasing about 2% per year and rivers increasing about 1% per year. In both the lakes and rivers long-term trends in recruits have declined about 5% per year since 1970. For the ESU as a whole, spawners and recruits have declined at a 5% rate over the past 33 years.

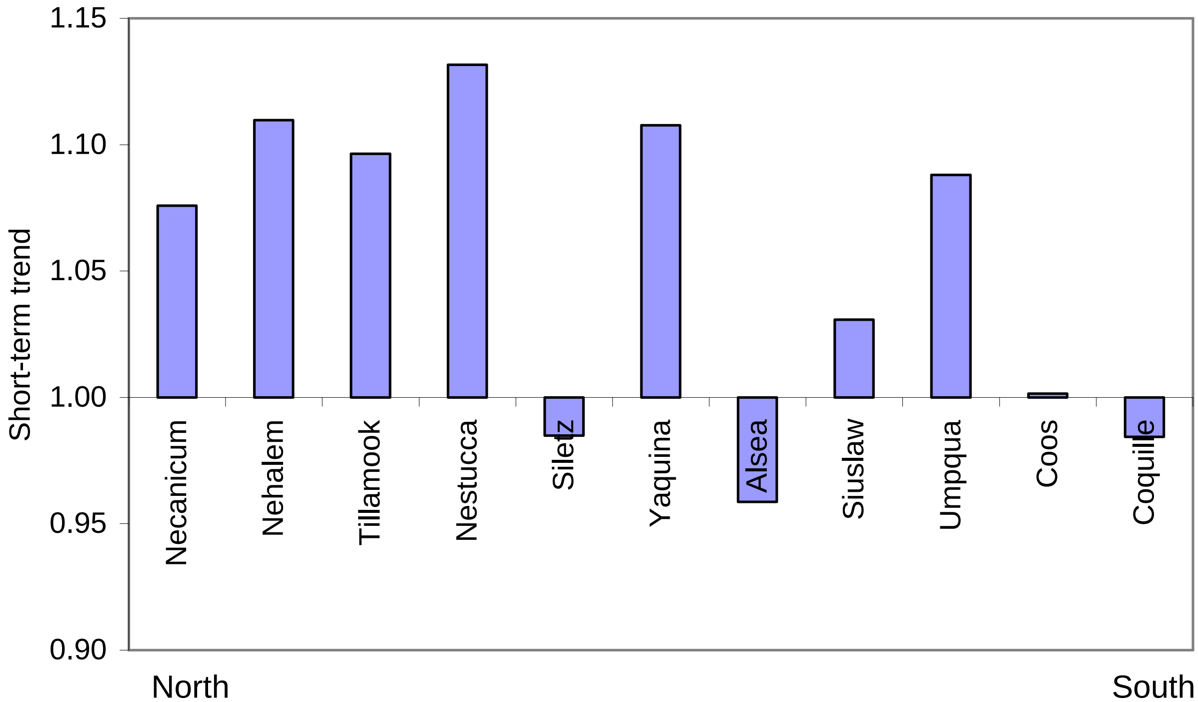


Figure C.2.1.6. Short-term (13-year, 1990-2002) trends in recruit abundance for 11 major river basins in the Oregon Coast coho salmon ESU. Basins are ordered from north to south.

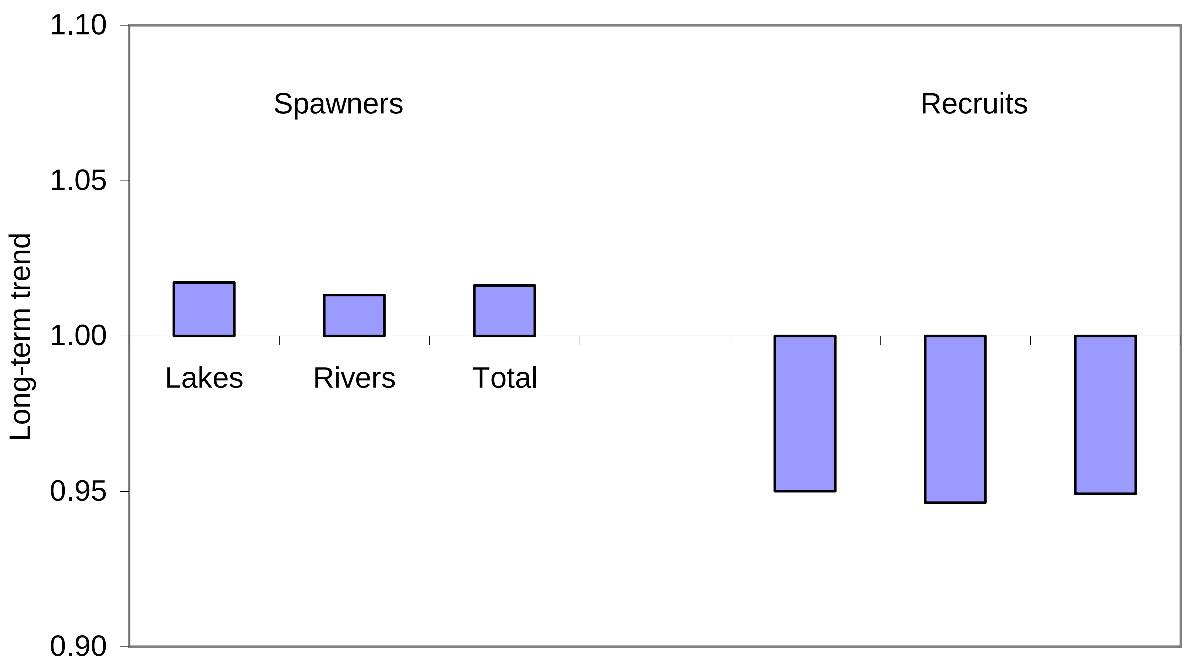


Figure C.2.1.7. Long-term trends (33 years, 1970 – 2002) for spawners and recruits in coastal lakes (Lakes), river basins (Rivers), and total OCN (Total) in the Oregon Coast coho salmon ESU.

Population spatial structure

We have very limited direct information about the spatial structure of these populations. Recent analyses (Nickelson and Lawson 1998, Nickelson 2001) have assumed that spawners from major river basins are largely isolated and that each basin comprises at least one population. The Umpqua River is large and diverse enough to hold several populations, but for the purposes of this analysis was considered as one. The three coastal lakes, Siltcoos, Tahkenitch, and Tenmile, are considered to be a single population, but may actually be separate. Genetic analyses are being conducted to resolve these questions, but results were not available at the time of this review. This is a change from the Status Review Update in 1997 (Schiewe 1997) when the coast was considered to consist of four populations, called "Gene Conservation Groups." Three of these groups (North/Mid Coast, Mid/South Coast, and Umpqua) were in the Oregon Coast ESU and the fourth (South Coast) was in the Southern Oregon/Northern California ESU.

Population diversity

New information on population diversity is anecdotal. With extremely low escapements in recent years many small systems have shown local extirpations. For example, Cummins Creek, on the central coast, had zero spawners in 1998 (Steve Johnson, Oregon Department of Fish and Wildlife, 2040 Marine Science Drive, Newport, Oregon , pers. commun. January 15, 2003), indicating the loss of a brood cycle. These systems are apt to be repopulated by stray spawners if abundances increase. Whether these events represent loss of genetic diversity or are indications of normal metapopulation function is not known.

Harvest impacts

Historical harvest rates on OPI area coho salmon were in the range of 60% to 90% from the 1960s into the 1980s. Modest harvest reductions were achieved in the late 1980s, but rates remained high until a crisis was perceived and most directed coho salmon harvest was prohibited in 1994. Subsequent fisheries have been severely restricted and most reported mortalities are estimates of indirect (non-catch) mortality in chinook fisheries and selective fisheries for marked (hatchery) coho. Estimates of these indirect mortalities are somewhat speculative and there is a risk of substantial underestimation.

Amendment 13—The Pacific Fishery Management Council adopted Amendment 13 (PFMC 1998) to their Salmon Fishery Management Plan in 1998. This amendment was developed as part of the Oregon Plan for Salmon and Watersheds (formerly OCSRI). It specified an exploitation rate harvest management regime with rates for OCN dependent on marine survival (as indexed by hatchery jack/smolt ratios) and parental and grand-parental spawning escapements. Exploitation rates ranged from 13% to a maximum of 35%. In 2000, Amendment 13 was reviewed, and the harvest rate matrix modified to include a 0-8% category under conditions of extremely poor marine survival as had been observed in the late 1990. At the same time, the maximum exploitation rate was increased to 45%. Exploitation rates were calculated to allow a doubling of spawners under conditions of moderate to good ocean survival.

Risk assessment was conducted for Amendment 13 (PFMC 1998) and the 2000 Amendment 13 Review (PFMC 2000) using the Nickelson/Lawson coho salmon habitat-based life-cycle model (Nickelson and Lawson 1998). The models were augmented to include a simulation of the fishery management process, including errors in spawner assessment, prediction, and harvest management. In general, the exploitation-rate management with a 35% cap showed a lower risk of pseudo-extinction than managing for an escapement goal of 200,000 spawners, but higher risk than a zero-harvest scenario. Starting from the very low escapements of 1994, basins on the North Coast had higher extinction risks than those on the Mid-North and Mid-South coasts.

Mark-selective fisheries—Beginning in 1998 most adult hatchery-origin coho salmon in the OPI area were marked with an adipose fin clip. This allowed the implementation of mark-selective fisheries, with legal retention only of marked fish. Unmarked fish were to be released unharmed. Recreational mark-selective fisheries have been conducted on the Oregon coast in each year since 1998, with quotas ranging from 13,000 to 24,000 marked fish. Commercial troll fisheries targeting chinook salmon were also operating.

Both fisheries catch and release coho salmon, resulting in incidental mortalities. In addition, some coho encounter the gear but escape or are eaten by predators – so called "drop-offs." Estimates of non-catch mortalities from hook and release and drop-off are difficult because they are, by their nature, unobserved. Field studies in the 1990s (NRC 1996) and a literature review and meta-analysis resulted in the adoption, by the PFMC, of hooking mortality rates of 13% for recreational fisheries and 24% for commercial fisheries. In addition, dropoff mortalities were assumed to equal 5% of the number of fish brought to the boat. Based on these mortality rates the PFMC uses a coho Fisheries Regulation Assessment Model (FRAM) to estimate noncatch mortalities in Council-managed fisheries. Post-season estimates of OCN exploitation rates based on FRAM modeling have ranged from 0.07 to 0.12 since the cessation on directed coho salmon fishing in 1994 (Table C.2.1.4). There is concern that these rates may be underestimates, and that actual mortalities may be greater. It is difficult to assess the risk to these stocks resulting from harvest at these levels.

Table C.2.1.4. OPI area hatchery marine survival, Oregon Coastal hatchery adult returns per smolt, and OPI area exploitation rate on unmarked coho salmon. All values are lagged to adult return year.

Year	OPI Hatchery Adults per Smolt	Coastal Hatchery Adults per Smolt	OPI Area Unmarked Exploitation Rate	OPI Marine Survival after Exploitation
1990	0.020	0.003	0.72	0.006
1991	0.050	0.007	0.57	0.022
1992	0.026	0.004	0.56	0.011
1993	0.011	0.003	0.45	0.006
1994	0.018	0.005	0.03	0.017
1995	0.024	0.005	0.23	0.018
1996	0.021	0.006	0.15	0.018
1997	0.006	0.005	0.13	0.005
1998	0.008	0.005	0.07	0.007
1999	0.011	0.008	0.08	0.010

2000	0.023	0.014	0.09	0.021
2001	0.050	0.044	0.07	0.046
2002	0.026	0.033	0.12*	0.023

*preseason estimate

Despite these uncertainties there is no doubt that harvest-related mortalities have been reduced substantially over the past decade. This reduction is reflected in positive short-term trends in spawner escapements (Figure C.2.1.5) despite continued downward trends in pre-harvest recruits for six of 11 major river basins (Figure C.2.1.6). Harvest management has succeeded in maintaining spawner abundance in the face of a continuing downward trend in productivity of these stocks. Further harvest reductions can have little effect on spawning escapements. Future remedies must be found outside of harvest management until the decline of productivity is reversed.

Habitat condition

Freshwater—The Oregon Plan for Salmon and Watersheds (Oregon Plan 1997) is the most ambitious and far-reaching program to improve watersheds and recover salmon runs in the Pacific Northwest. It is a voluntary program focused on building community involvement, habitat restoration, and monitoring. All State agencies with activities affecting watersheds are required to evaluate their operations with respect to salmon impacts and report on actions taken to reduce these impacts to the Governor on a regular basis. The original Coastal Salmon Restoration Initiative was written in 1997, so the Plan has been in operation for about 5 years. As a result of the plan, watershed councils across the State have produced watershed assessments of limiting factors for anadromous salmonids on both public and private land. The State of Oregon has dedicated about $20 million/year to implement restoration projects and is developing a system to link project development with whole-watershed assessments. The Oregon Department of Environmental Quality and the Oregon Department of Agriculture are implementing regulatory mechanisms to reduce non-point-source pollution. If these efforts are successful Oregon could see a widespread improvement in water quality. There is room for improvement in the reporting of watershed assessment results and limiting factors, and identification of actions to be taken or progress made in addressing these limiting factors. While this is a significant recovery effort in the Pacific Northwest, and an extensive, coordinated monitoring program is in place, measurable results of the program will take years or decades to materialize.

Marine—The regime shift in 1976 was the beginning of an extended period of poor marine survival for coho salmon in Oregon. Conditions worsened in the 1990s, and OPI hatchery survival reached a low of 0.006 adults per smolt in 1997 (1996 ocean entry, Table C.2.1.4). Coastal hatcheries appear to have fared even worse, although adult counts at these facilities are often incomplete, biasing these estimates low. Following an apparent shift to a more productive climate regime in 1998 marine survival has started to improve, reaching 0.05 for adults returning in 2001 (Table C.2.1.4). The Pacific Decadal Oscillation (PDO) had been in a cold, productive phase for about 4 years and in August reversed indicating a warm, unproductive period. This reversal may be short-lived; the PDO historically has show a 20-60 year cycle. However, "the rising influence of global warming should throw up a big caution sign to us when trying to use past decadal patterns as predictive models for the future" (Nathan J. Mantua, School of Marine

Affairs/Joint Institute for the Study of Atmospheric and Oceanic Climate Impacts Group, University of Washington, Seattle, pers. commun. January 7, 2003).

Table C.2.1.5. Millions of smolts released, adult returns, and number of operating hatcheries on the Oregon Coast from 1990 to 2002. [1]Excludes three small hatcheries: Elk River, Cedar Creek, and Eel Lake. [2]An additional 5.4 million smolts were released from private facilities in 1990.

Year	Smolts Released (millions)	Adult Returns to Hatchery	Number of Hatcheries[1]
1990[2]	5.70	15,489	6
1991	5.30	39,555	6
1992	6.20	23,307	6
1993	4.33	20,209	6
1994	5.02	23,435	6
1995	3.71	25,173	6
1996	3.28	23,422	7
1997	2.92	17,776	7
1998	1.66	15,287	7
1999	1.06	13,347	6
2000	0.86	14,984	5
2001	0.93	38,149	5
2002	0.98	30,862	5

A long-term understanding of the prospects for OCN coho can be constructed from a simple conceptual model incorporating a trend in habitat quality and cyclical ocean survival (Figure C.2.1.8, Lawson 1993). Short-term increases in abundance driven by marine survival cycles can mask longer-term downward trends resulting from freshwater habitat degradation (as in Figure C.2.1.8) or longer-term trends in marine survival that may be a consequence of global climate change. Decreases in harvest rates (C in Figure C.2.1.8) can increase escapements and delay ultimate extinction (D in Figure C.2.1.8). Harvest rates have been reduced to the point where no further meaningful reductions are possible. The current upswing in marine survival is a good thing for OCN coho, but will only provide a temporary respite unless other downward trends are reversed.

C.2.1.4. New Hatchery Information

Interactions between hatchery and wild fish are generally considered to have negative outcomes for the wild fish. A growing body of literature documents reduced spawning success, freshwater survival and production of wild fish when hatchery fish are present (IMST 2001, Einum and Fleming 2001, Flagg et al. 2000, Independent Scientific Group 1996, National Research Council 1996, Flagg and Nash 1999, Chilcote 2002). Additional negative interactions are associated with mark-selective fisheries directed at hatchery coho salmon in the ocean. In the past 12 years there have been closures of some Oregon coastal hatchery facilities, reduction in numbers of smolts released from the remaining facilities, and efforts to

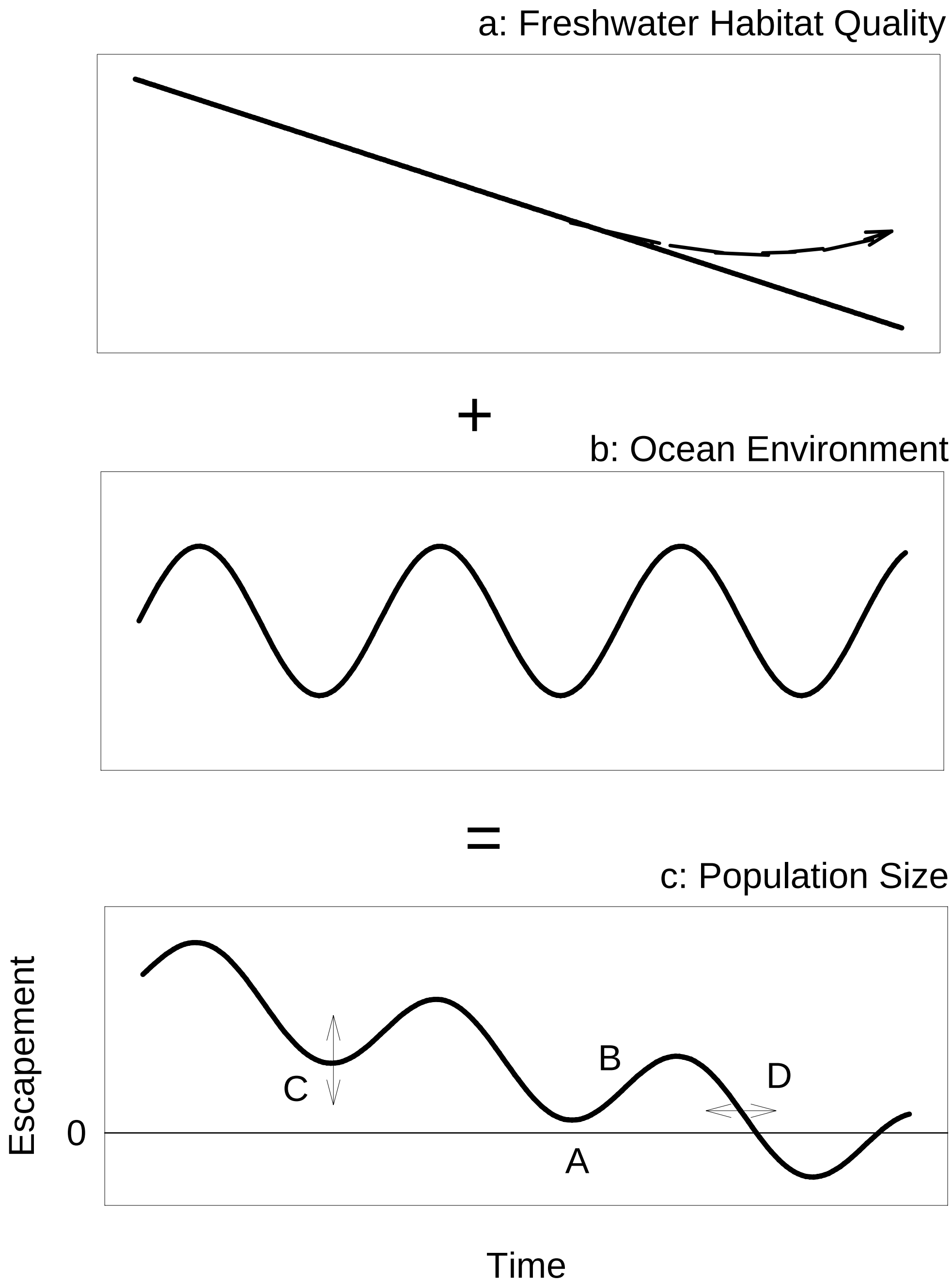


Figure C.2.1.8. Conceptual model of effects of declining habitat quality and cyclic changes in ocean productivity on the abundance of Oregon's coastal natural coho salmon. a: trajectory over time of habitat quality. Dotted line represents possible effects of habitat restoration projects. b: generalized time series of ocean productivity. c: sum of top two panels. Labeled points on c: A = situation in the mid 1990s, B = current situation, C = change in escapement from increasing or decreasing harvest, and D = change in time of extinction from increasing or decreasing harvest. Figure from Lawson 1993 include more native broodstock. In principle, these changes should somewhat reduce risks to naturally spawning coho on the Oregon coast.

Starting in 1999 most adult coho salmon of hatchery origin were marked with an adipose fin clip. This has enabled the introduction of mark-selective fisheries for hatchery (fin-clipped) coho salmon. An additional benefit is better accounting of hatchery fish spawning in the wild.

Hatchery smolts released are reported in Table C.2.1.5. Numbers have dropped from a high of 6.2 million in 1992 to 0.93 million in 2001. Over that time period several small hatcheries have closed or stopped releasing coho. For three years (1995 – 1997) coho smolts were released from the acclimation facility on Yaquina Bay. In 1999 Fall Creek Hatchery on the Alsea River stopped releasing coho salmon smolts. The percentage of hatchery-origin spawners on natural spawning grounds has also decreased (Figure C.2.1.9, Table C.2.1.6, Table C.2.1.7). Throughout most of the 1990s, the percentage of natural spawners that were of hatchery origin exceeded 10% in over half of Oregon coast basins and exceeded 70% in three. By contrast, in the most recent three years the proportion of hatchery-origin spawners has generally been much lower (Table C.2.1.6, Table C.2.1.7). The decrease is most notable in North Coast systems that had up to 70% hatchery spawners in the early 1990s and have averaged below 5% since 1999. Both the Tillamook and Umpqua basins continue to show elevated numbers of hatchery-origin spawners in most years, and the Alsea River had 7% hatchery spawners in 2001 despite the closure of the Fall Creek Hatchery in that system.

Overall, the reduction in hatchery activity is expected to benefit wild runs. However, it may take several years before these benefits become apparent, depending on the mix of demographic and genetic effects on natural production. In the meantime, the future of the hatchery program is uncertain. On one hand, public opinion and a perceived short-term benefit may create pressure to increase hatchery activity despite the likely negative effects on wild runs. On the other hand, Oregon State budget problems may force additional hatchery closures. The Trask and Salmon River hatcheries were scheduled to be closed in 2001 but were given a last-minute reprieve by the Oregon Legislature.

Jacobs et al. (2000) discuss potential errors associated with the change in methodology used to determine the origin of natural spawners. Prior to 1998, hatchery or wild origin was determined primarily by scale analysis, while mass marking permitted the use of adipose fin clips beginning in 1998. In 1998 and 1999 both methods were used. Comparison of results from the two methodologies show that scales tend to indicate greater proportion of hatchery fish than fin clips, although there are limitations associated with both methodologies. The primary limitation of scale analysis is availability of adequate reference scales for naturally produced fish, while marking programs may not actually mark 100% of the fish as intended.

Estimates of hatchery fish contribution rates from scale analysis are complicated by the low sample sizes collected during the extremely low coho abundances in the 1990s. ODFW determined that acceptable estimates of hatchery contribution rates could not be made in cases where fewer than 10 scales were collected in a basin in a year. These were reported as zero percent hatchery fish even when hatchery scales were observed in the sample. Small sample zeros are not distinguishable from true zeros in Table C.2.1.7, resulting in an under reporting of hatchery contributions that we are unable to evaluate. Figure C.2.1.9 attempts to minimize this problem by aggregating data over the years 1992-1998, and probably presents a truer overall picture for that time period of general patterns in hatchery fish distribution in the ESU.

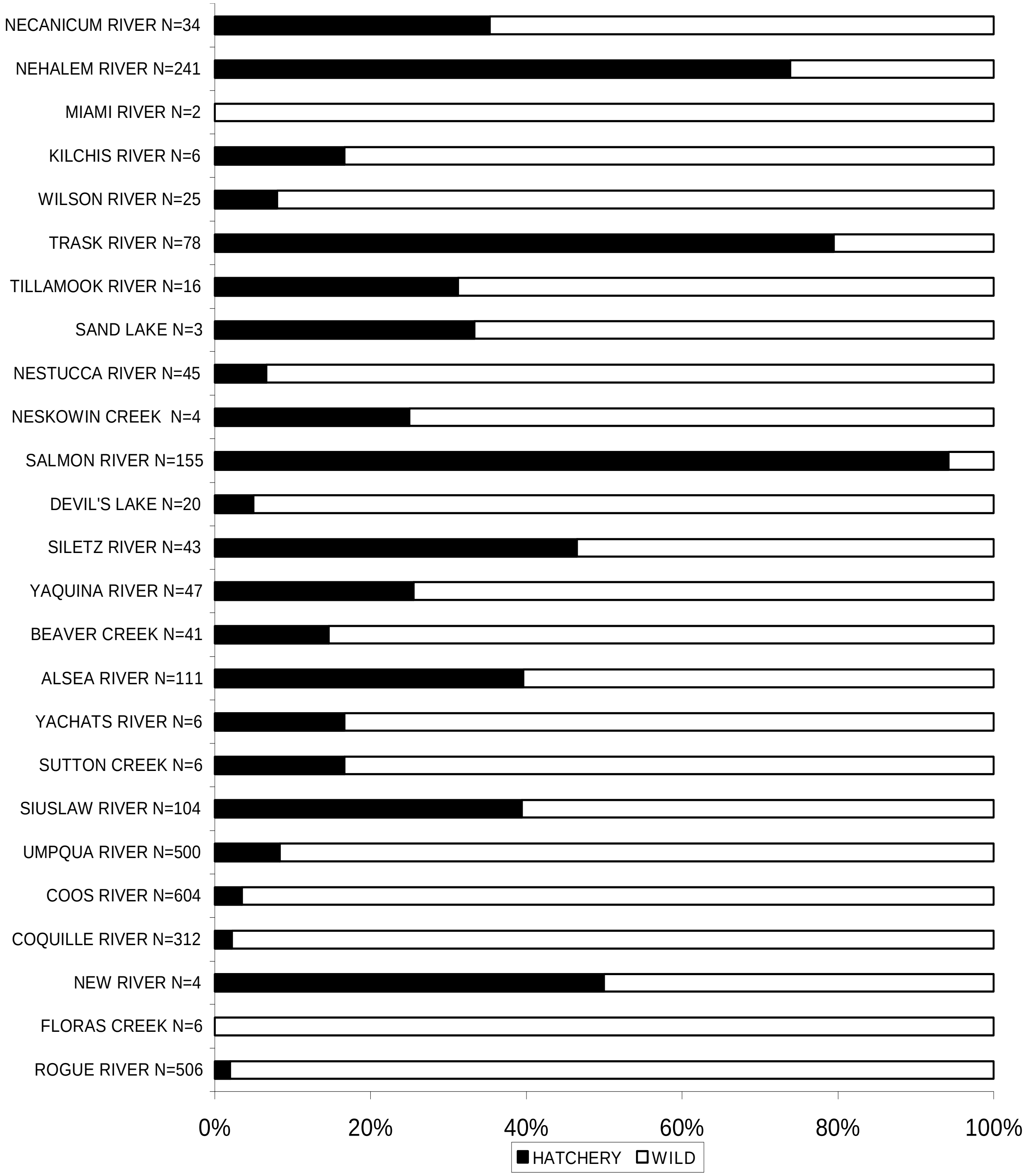


Figure C.2.1.9. Rearing origin of naturally spawning adult coho salmon in major coastal river basins over the 6-year period of 1992-98. Estimates derived from analysis of scales collected on random spawning surveys. Samples from the Rogue Basin are only from the most recent 3-year period (1996-98). Solid bars represent hatchery fish and open bars represent naturally produced fish. Reproduced from Jacobs et al. 2000.

Table C.2.1.6. Percent of natural spawning coho salmon of hatchery origin based on fin clips from carcasses (1998, 1999) or both carcasses and live fish (2000-2002). Hatchery percentages from 1998 and 1999 are adjusted by marked:unmarked ratios at nearest hatchery facility. Data from Jacobs et al. 2000, 2001, 2002, and Jacobs pers. comm. (4/9/03).

Major Basin	1998		1999		2000		2001		2002	
	n	% H	n	% H	n	% H	n	% H	n	% H
North Coast:										
Necanicum & Elk Creek	2	0.0	8	0.0			605	6.4	280	2.9
Nehalem[1]	22	26.0	14	0.0	1,995	0.5	2,735	2.0	2,535	6.2
Tillamook Bay	1	0.0	18	5.6	224	10.8	124	4.1	1,874	2.0
Nestucca	1	0.0	20	0.0	188	2.1	212	10.4	1,034	1.6
North Coast totals, Avg.	26	22.0	60	1.7	2,407	1.6	3,676	3.3	5,723	3.8
Mid-North:										
Salmon	142	98.6	6	17.5					145	34.5
Siletz[2]	2	100.0	5	41.9	185	2.7	153	12.4	171	1.8
Yaquina	16	37.5	6	0.0			239	1.7	1,579	0.3
Devil's Lk. & Beaver Cr.	19	21.1	13	0.0			193	1.6	527	0.8
Alsea	24	87.5	4	0.0	107	2.8	162	7.4	448	0.2
Siuslaw	9	11.1	15	6.7	351	0.9	782	1.2	3,240	0.3
Coastal lakes	647	0.0	80	1.3	54	0.0	183	0.0	3,293	0.1
Mid-North totals, Avg.	859	20.3	129	4.0	697	1.6	1,712	2.8	9403	0.8
Umpqua:										
Smith[3]	59	0.0	25	0.0	693	0.4	1,603	2.3	2,252	1.1
Mainstem Umpqua	7	14.3	17	5.9	209	3.3	508	40.8	617	5.8
Elk & Calapooya Cr.	10	10.0	13	15.4	231	3.9	158	1.3	204	2.9
South Umpqua	11	36.4	47	6.4			285	4.6	67	0.0
Cow Creek	21	14.0	34	3.0	124	21.8	498	5.1	192	1.6
Umpqua totals, Avg.	108	8.3	136	5.2	1,257	3.7	3,052	9.3	3,332	2.1
Mid-South										
Coos Bay	53	1.9	85	0.0	376	0.0	2,569	0.8	4,145	0.3
Coquille	29	0.0	40	0.0	431	0.2	1,733	6.0	880	0.9
Tenmile Lake	51	0.0	80	0.0	65	0.0	767	0.1	341	1.5
Floras Cr & New R	10	0.0	4	0.0			217	5.1	2	0.0
Mid-South Totals, Avg.	143	0.7	209	0.0	872	0.1	5,286	2.6	5368	0.4
Coast-wide *Totals, Avg.*	1,136	16.7	534	2.5	5,233	1.8	13,726	4.3	23,826	1.6

[1]2002 data is missing dead fish from North Nehalem, area of high hatchery straying.
[2]In 2002, does not include recoveries from Steer Cr., located near Siletz Tribal Release Point. With Steer Cr. recoveries, n = 435, % H = 49.4%.
[3]Includes Lower Umpqua River in 2000, 2001, and 2002

Table C.2.1.7 Proportion of natural spawning fish of hatchery origin. Data from 1990-1997 are based on scale analysis. In some cases with insufficient data ODFW reported 0.00 hatchery spawners when, in fact, hatchery spawners may have been present. Data from 1998-2002 are based on fin clips.

Management Area:	**Return Year**												
Location	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
North Coast:													
Necanicum and													
Elk Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
Nehalem	0.65	0.22	0.43	0.81	0.43	0.49	0.74	0.45	0.23	0.00	0.00	0.02	0.08
Tillamook Bay	0.00	0.00	0.00	0.53	0.29	0.62	0.14	0.08	0.00	0.06	0.11	0.13	0.02
Nestucca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.02
Sand Lake and													
Neskowin Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00	0.00
North Coast Avg.	0.57	0.11	0.28	0.70	0.34	0.33	0.49	0.32	0.12	0.02	0.02	0.02	0.05
Mid-North:													
Salmon	0.11	0.00	0.80	0.00	0.93	0.84	0.90	0.43	0.99	0.17	1.00	0.76	0.20
Siletz	0.00	0.71	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.30	0.45
Yaquina	0.38	0.00	0.00	0.00	0.00	0.00	0.16	0.27	0.38	0.00	0.00	0.05	0.00
Beaver Creek	0.00		0.00	0.00	0.00		0.00	0.00	0.21	0.00	0.00	0.07	0.00
Alsea	0.01	0.00	0.17	0.00	0.00	0.00	0.00	0.27	0.87	0.00	0.00	0.15	0.00
Yachats	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siuslaw	0.00	0.00	0.00	0.04	0.38	0.00	0.26	0.00	0.11	0.07	0.00	0.00	0.00
Miscellaneous	0.00	1.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00	0.00	0.00
Mid-North Avg.	0.05	0.26	0.14	0.02	0.26	0.08	0.25	0.17	0.45	0.08	0.04	0.09	0.02

Table C.2.1.7 (continued).

Umpqua:													
Lower Umpqua and Smith	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.03	0.01	0.02
Umpqua	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.06	0.08	0.32	0.04
Elk Creek and Calapooya Creek	0.00				0.00	0.00	0.00	0.00	0.10	0.15	0.03	0.02	0.00
South Umpqua	0.00	0.00		0.00	0.00	0.08	0.77	0.21	0.05	0.04	0.00	0.08	0.00
Cow Creek			0.00	0.00	0.71	0.08	0.58	0.00	0.67	0.00	0.09	0.09	0.02
Umpqua Avg.	0.06	0.00	0.00	0.00	0.13	0.01	0.43	0.08	0.09	0.03	0.05	0.14	0.02
Mid-South													
Coos Bay and Big Creek	0.00	0.00	0.03	0.05	0.03	0.01	0.00	0.00	0.02	0.00	0.00	0.02	0.00
Coquille	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.01
Mid-South Avg.*	0.00	0.00	0.02	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
Coast-wide Rivers	0.17	0.11	0.09	0.21	0.15	0.07	0.22	0.11	0.16	0.03	0.03	0.07	0.02
Lakes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coast-wide Total	0.17	0.11	0.09	0.21	0.15	0.07	0.22	0.11	0.16	0.03	0.03	0.07	0.02

* Excluding Floras Creek and Sixes River.

C.2.2 SOUTHERN OREGON/NORTHERN CALIFORNIA COASTS COHO SALMON

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C.2.2.1 Summary of Previous BRT Conclusions

The Southern Oregon/Northern California Coast (SONCC) coho salmon Evolutionarily Significant Unit (ESU) extends from Cape Blanco in southern Oregon to Punta Gorda in northern California (Weitkamp et al. 1995). The status of coho salmon coastwide, including the SONCC ESU, was formally assessed in 1995 (Weitkamp et al. 1995). Two subsequent status review updates have been published by NMFS, one addressing all West Coast coho salmon ESUs (NMFS 1996b) and a second specifically addressing the Oregon Coast and Southern Oregon-Northern California ESUs (NMFS 1997). Information from those reviews regarding extinction risk, risk factors, and hatchery influences is summarized in the following sections.

Status indicators and major risk factors

California populations—Data on population abundance and trends were limited for the California portion of the SONCC ESU. The BRT found no regular estimates of natural spawner escapement for coho salmon in the SONCC, and most information used by the BRT came from reviews by California Department of Fish and Game (CDFG 1994) and Brown et al. (1994). Historical point estimates of coho salmon abundance for the early 1960s and mid 1980s cited in these reviews were taken from CDFG (1965), Wahle and Pearson (1987), and Sheehan (1991)[2]. These estimates suggest that statewide coho spawning escapement in the 1940s ranged between 200,000 and 500,000 fish (E. Gerstung, CDFG pers. comm. cited in Brown et al. 1994). By the early-to-mid 1960s, statewide escapement was estimated to have declined to just under 100,000 fish (CDFG 1965), with approximately 43,000 fish (44%) originating from rivers within the SONCC ESU (Table C.2.2.1). Wahle and Pearson (1987) estimated that statewide coho salmon escapement had declined to approximately 30,000 fish by the mid-1980s, with about 12,400 (41%) originating within the SONCC ESU. For the late 1980s, Brown et al. (1994) estimated wild and naturalized coho salmon populations at 13,240 for the state, and 7,080 (53%) for the California portion of the SONCC ESU. To derive their estimate, they employed a "20-fish rule" in which all streams known to historically support coho salmon, except those for which recent surveys indicated coho salmon no longer persist (19% of the total), were assumed to still support 20 spawners. For streams where a recent estimate of spawner abundance existed, they used either that estimate or 20 fish, whichever was larger. They suggested that application of the "20-fish rule" likely overestimated total abundance. As Brown et al. (1994) point out, all of these historical estimates are "guesses" of fishery managers and biologists generated using a combination of limited catch statistics, hatchery records, and personal observations.

[2]For mid-1980s estimates, Brown et al. (1994) cite Wahle and Pearson (1987) who estimate 30,480 total spawners in California whereas CDFG (1994) cites Sheehan's (1991) estimate of 33,500 spawners. It is unclear how Sheehan's estimates were derived and no basin-specific estimates are presented; thus, we have included the estimates of Wahle and Pearson (1987) in Table C.2.2.1 rather than the Sheehan (1991) estimates cited by the BRT (Weitkamp 1995).

Table C.2.2.1. Historical estimates of coho salmon spawner abundance for various rivers and regions within the Southern Oregon/Northern California Evolutionarily Significant Unit.

	Estimated Escapement		
	CDFG (1965)[a]	**Wahle & Pearson (1987)[b]**	**Brown et al. (1994)[c]**
River/Region	**1965**	**1984-1985**	**1987-1991**
CA rivers trib. to OR coast streams	1,000		
Smith River	5,000	2,000	820[d]
Other Del Norte County	400		180[d]
Klamath River	15,400	3,400	1,860
Mainstem Klamath River & tribs.	8,000	1,000	
Shasta River	800	300	
Scott River	800	300	
Salmon River	800	300	
Trinity River	5,000	1,500	
Redwood Creek	2,000	500	280
Mad River	2,000	500	460
Eel River	14,000	4,400	2,040[d]
Mainstem Eel River	500	200	
Van Duzen River	500	200	
South Fork Eel River	13,000	4,000	
North Fork Eel River	0	0	
Middle Fork Eel River	0	0	
Mattole River	2,000	500	760[d]
Other Humboldt County	1,500	1,130	680[d]
ESU Total	43,300	12,430	7,080
California Statewide Total[e]	99,400	30,480	13,240

a. Excludes ocean catch.

b. Estimates are for wild or naturalized fish; hatchery returns excluded.

c. Estimates are for wild or naturalized fish; hatchery returns excluded. For streams without recent spawner estimates (or estimates lower than 20 fish), assumes 20 spawners.

d. Indicates high probability that natural production is by wild fish rather than naturalized hatchery stocks.

e. Estimated number of coho salmon for CCC ESU and California portion of the SONCC ESU combined.

Additional information regarding the status of coho salmon in the SONCC ESU was obtained from an analysis of recent (1987-1991) occurrence of coho salmon in streams historically known to support coho populations (Brown et al. 1994). Of 115 historical streams in the SONCC ESU for which recent data were available, 73 (63%) were determined to still support coho salmon, whereas it was believed they had been lost from 42 (37%). The estimated percentage of streams with coho salmon still present was lower for Del Norte County (55%) than for Humboldt County (69%). NMFS (1996b) presented more recent data (1995-1996) on presence of coho salmon within the SONCC ESU, which suggested that the percentage of streams still supporting coho salmon was lower than estimated by Brown et al. (1994). Of 176 streams recently surveyed in the SONCC ESU, 92 (52%) were found to still support coho salmon (P. Adams, NMFS Southwest Fisheries Science Center, pers. comm. cited in NMFS 1996b). The estimated percentage of streams still supporting coho salmon was lower (46%) in Del Norte County than in Humboldt County (55%).

Two recent reviews assessing the status of coho salmon stocks in California were also reviewed by the BRT. Nehlsen et al. (1991) identified coastal populations of coho salmon north of San Francisco Bay (includes portions of the SONCC and CCC ESUs) as being at moderate risk of extinction and Klamath River coho salmon as a stock of special concern. The Humboldt Chapter of the American Fisheries Society (Higgins et al. 1992), utilizing more detailed information on individual river basins, considered three stocks of coho salmon in the SONCC ESU as at high risk of extinction (Scott River [Klamath], Mad River, and Mattole River), and eight more stocks as of special concern (Wilson Creek, Lower Klamath River, Trinity River, Redwood Creek, Little River, Humboldt Bay tributaries, Eel River, and Bear River)[3].

Oregon populations—For the 1997 status update (NMFS 1997), the BRT was asked to evaluate the status of the ESU under two conditions: first, under existing conditions; second, assuming that hatchery and harvest reforms of the Oregon Coastal Salmon Restoration Initiative (OCSRI) were implemented.

Evaluation under existing conditions—In the Rogue River Basin, natural spawner abundance in 1996 was slightly above levels in 1994 and 1995. Abundances in the most recent 3 years were all substantially higher than abundances in 1989-1993, and were comparable to counts at Gold Ray Dam (upper Rogue) in the 1940s. Estimated return ratios for 1996 were the highest on record, but this may have been influenced by an underestimate of parental spawners. The Rogue River run included an estimated 60% hatchery fish in 1996, comparable to previous years. The majority of these hatchery fish returned to Cole Rivers Hatchery, but there was no estimate of the number that strayed into natural habitat.

Evaluation with hatchery and harvest reforms—The BRT considered only two sets of measures from the OCSRI—harvest management reforms and hatchery management reforms. The BRT did not consider the likelihood that these measures will be implemented; rather, it only considered the implications for ESU status if these measures were fully implemented as described. The BRT had several concerns regarding both the harvest and hatchery components of the OCSRI plan. Some members had a strong concern that we do not know enough about the

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[3] Weitkamp et al. (1995), citing Higgins et al. (1992), indicate that the numbers of stocks at "moderate risk of extinction" and "of special concern" in the SONCC are 6 and 10, respectively. These numbers appear to be in error.

causes of declines in run size and recruits per spawner to be able to directly assess the effectiveness of specific management measures. Some felt that the harvest measures were the most encouraging part of the plan, representing a major change from previous management. However, there was concern that the harvest plan might be seriously weakened when it is re-evaluated in the year 2000 and concern about our ability to effectively monitor non-target harvest mortality and to control overall harvest impacts.

Of the proposed hatchery measures, substantial reductions in smolt releases were thought to have the most predictable benefit for natural populations; all else being equal, fewer fish released should result in fewer genetic and ecological interactions with natural fish. Marking all hatchery fish should also help to resolve present uncertainties about the magnitude of these interactions. However, the BRT expressed concerns regarding some aspects of the proposed hatchery measures. The plan was vague on several key areas, including plans for incorporation of wild broodstock and how production would be distributed among facilities after 1997. One concern was that the recent and proposed reductions appear be largely motivated by economic constraints and the present inability to harvest fish if they were produced rather than by recognition of negative effects of stray hatchery fish on wild populations. Other concerns expressed by the BRT included no reductions in fry releases in many basins and no consideration of alternative culture methods that could be used to produce higher-quality hatchery smolts, which may have less impact on wild fish. Another concern was the plan’s lack of recognition that hatchery-wild interactions reduce genetic diversity among populations.

Specific risk factors identified by the BRT included low current abundance, severe decline from historical run size, the apparent frequency of local extinctions, long-term trends that are clearly downward, degraded freshwater habitat and associated reduction in carrying capacity, and widespread hatchery production using exotic stocks. Of particular concern to the BRT was evidence that several of the largest river basins in the SONCC—including the Rogue, Klamath, and Trinity rivers—were heavily influenced by hatchery releases of coho salmon. Historical transfer of stocks back and forth between SONCC and CCC streams was common, and SONCC streams have also received plants from stocks from hatcheries in the lower Columbia River/Southwest Washington, Puget Sound/Strait of Georgia, and Oregon Coast ESUs. However, the BRT considered the frequency of out-of-basin plants to be relatively low compared with other coho salmon ESUs. Recent (late 1980s and early 1990s) droughts and unfavorable ocean conditions were identified as further likely causes of decreased abundance.

Previous BRT conclusions

In the 1995 status review, the BRT was unanimous in concluding that coho salmon in the SONCC ESU were not in danger of extinction but were likely to become so in the foreseeable future if present trends continued (Weitkamp et al. 1995). In the 1997 status update, estimates of natural population abundance in this ESU were based on very limited information. Favorable indicators included recent increases in abundance in the Rogue River and the presence of natural populations in both large and small basins, factors that may provide some buffer against extinction of the ESU. However, large hatchery programs in the two major basins (Rogue and Klamath/Trinity) raised serious concerns about effects on, and sustainability of, natural populations. New data on presence/absence in northern California streams that historically supported coho salmon were even more disturbing than earlier results, indicating that a smaller percentage of streams in this ESU contained coho salmon compared to the percentage presence in an earlier study. However, it was unclear whether these new data represented actual trends in local extinctions, or were biased by sampling effort. This new information did not change the BRT's conclusion regarding the status of the SONCC ESU. Although the OCSRI proposals were directed specifically at the Oregon portion of this ESU, the harvest proposal would affect ocean harvest of fish in the California portion as well. The proposed hatchery reforms can be expected to have a positive effect on the status of populations in the Rogue River Basin. However, the BRT concluded that these measures would not be sufficient to alter the previous conclusion that the ESU is likely to become endangered in the foreseeable future.

Listing status

Coho salmon in the SONCC ESU were listed as threatened in May of 1997 (62FR24588). On July 18, 1997, NMFS published an interim rule (62FR38479) that identified several exceptions to the Endangered Species Act's Section 9 take prohibitions.

C.2.2.2 New Data and Updated Analyses

Because data types and sources differ substantially between the California and Oregon portions of the ESU, we present information separately for each area.

California populations

Since the status review for West Coast coho salmon (Weitkamp et al. 1995) and subsequent updates (NMFS 1996b, and NMFS 1997) were completed, new data and analyses related to the status of coho salmon in the California portion of the SONCC ESU have become available. Most data are of two types: 1) compilations of presence-absence information for coho streams from the period 1987 to the present, and 2) new data on densities of juvenile coho salmon in index reaches surveyed by private timber companies. We found no time series of adult counts (excepting those substantially influenced by hatchery production), and only five time series of adult spawner indices (maximum live/dead counts) for tributaries of the Eel River (Sprowl Creek), the Mad River (Canon Creek), and the Smith River (West Branch of Mill Creek [two datasets] and East Branch of Mill Creek) that span a period of 8 years or more, none of which are considered reliable indicators of population trends. Limitations of these datasets are discussed in detail below.

Two independent analyses of presence-absence and limited time series data for the SONCC have been published recently. CDFG (2002) analyzed coho salmon presence-absence for SONCC streams spanning broodyears 1986-2000. NMFS (2001b) published an updated status review for coho salmon in the California portion of the SONCC, which also included analysis of presence-absence information. Since then, scientists at the Southwest Fisheries Science Center have continued compiling data on coho salmon distribution and abundance and re-analyzed the updated data, inclusive of data used in the CDFG (2002) analysis. Thus, results presented in this report supercede those presented in NMFS (2001b).

CDFG presence-absence analysis

Methods—Staff at the North Coast Region of the California Department of Fish and Game attempted to gather all published and unpublished data collected for 392 streams identified by Brown and Moyle (1991) as historical coho salmon streams[4]. Sources of data included field notes, planting records, and fish surveys from federal, state and tribal agencies, private landowners, and academic institutions, as well as summaries contained in several recently published status reviews (Ellis 1997, Brownell et al. 1999, and NMFS 2001b). For each stream and year in which surveys were conducted, observations of coho salmon presence or absence were assigned to the appropriate broodyear. If more than one life stage was observed during a survey, then presence was assigned to more than one broodyear. Streams that were not surveyed during a particular year were assigned a "presence" value if fish were documented in an upstream tributary during that year. Overall, the CDFG dataset encompasses records from broodyear 1986 to 2000, or five complete brood cycles. Additionally, CDFG (2002) presented results of an extensive field study conducted in the summer of 2001 in which 287 of the 392 Brown and Moyle (1991) streams were surveyed for juvenile coho salmon presence-absence[5].

For their brood-year analysis, CDFG (2002) compared the percentage of streams for which coho salmon were detected at any time during two time periods: broodyears 1986-1991 and 1996-2000. The first period was designed to coincide with the period encompassed by the Brown and Moyle (1991) study. Statistics were generated based on data from all streams within the SONCC on the original Brown and Moyle list as well as the subset of these streams that were sampled at least once during each of the two time periods. CDFG (2002) also calculated the percentage of streams for which coho salmon were detected in the 2001 field survey.

Results—Including only streams on the Brown and Moyle list, CDFG (2002) found that coho salmon were observed in 143 of 235 (61%) streams surveyed during the period covering broodyears 1986-1991 (Table C.2.2.2). This number is similar to the value of 63% found by Brown and Moyle (1991) based on information on about half as many streams (115). For broodyears 1995-2000, surveys were conducted on 355 of the 392 historical coho salmon streams. Of these, coho salmon were detected in 179 (50%), suggesting a decline in occupancy. However, when the analysis was restricted to only the 223 streams for which data were available from both time periods, the percent of streams in which coho were detected went from 62% in 1986-1991 to 57% in 1995-2000, a change that was not statistically significant (Pearson Chi square test, $p = 0.228$; Yates corrected chi square test, $p = 0.334$).

For the 2001 field survey, presence was confirmed in only 121 (42%) of the 287 streams surveyed within the SONCC ESU. CDFG (2002) makes two cautions in interpreting their year 2001 results. First, CDFG considered sampling intensity to be sufficient to have a high likelihood of detecting fish for only 110 of the 166 streams where coho salmon were not found. Second, they note that absence of fish in a single year class does not mean that fish have been extirpated from the system.

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[4]Brown and Moyle (1991) identified 396 streams in California as historical coho streams; however, four of those streams were dropped by CDFG either because barriers make historically occupancy highly unlikely, because the record of occurrence likely reflects a hatchery outplanting, or because streams were duplicated in the Brown and Moyle list.
[5]CDFG repeated their survey of Brown and Moyle (1991) streams in the summer of 2002; however, those data were unavailable at the time of their analysis.

Table C.2.2.2. Historical presence of coho salmon in the SONCC ESU, as determined by Brown and Moyle (1991) and the California Department of Fish and Game's presence-by-broodyear investigation (as of February 2002). County classifications are based on the location of the mouth of the river system. Table modified from CDFG (2002).

	Brown and Moyle (1991) Calendar years 1987-1990				**CDFG (2002) Broodyears 1986-1991**				**CDFG (2002) Broodyears 1995-2000**			
County/River Basin	**# of streams**	**# of streams w/info.**	**coho present**	**%**	**# of streams**	**# of streams w/info.**	**coho present**	**(%)**	**# of streams**	**# of streams w/info.**	**coho present**	**%**
Del Norte County												
Coastal	9	1	1		8	5	3		8	8	6	
Smith River	41	2	2		41	21	7		41	39	14	
Klamath River	113	41	21		112	82	48		112	89	55	
Subtotal	163	44	24	54%	161	108	58	53%	161	136	75	55%
Humboldt County												
Coastal	34	7	7		33	16	14		33	32	18	
Redwood Creek	14	3	3		14	12	12		14	14	11	
Mad River	23	2	2		23	10	8		23	22	14	
Eel River	124	56	34		123	80	48		123	116	45	
Mattole River	38	3	3		38	9	3		38	35	16	
Subtotal	233	71	49	69%	231	127	85	67%	231	219	104	47%
ESU Total	396	115	73	63%	392	235	143	61%	392	355	179	50%

NMFS presence-absence analysis

Methods—Scientists at the NMFS Southwest Fisheries Science Center compiled a presence-absence database for the SONCC similar to that developed by CDFG. The dataset includes information for coho salmon streams listed on the Brown and Moyle (1991) list, as well as other streams for which we have found historical or recent evidence of coho salmon presence. The dataset is a composite of information contained in the NMFS (2001b) status review update, additional information gathered by NMFS since the 2001 status review was published, data used in the CDFG (2002) analysis, and additional data compiled by CDFG (Bill Jong, CDFG, North Coast Region, unpublished data) for streams not on the Brown and Moyle (1991) list. As such, the database combines information taken from primary sources such as stream surveys, data reports, and electronic files, as well as from secondary sources, including recent compilations of presence-absence data by Ellis (1997), Brownell et al. (1999), NMFS (2001b), CDFG (2002); and Bill Jong, CDFG (unpublished data). In many cases, were unable to obtain original sources underlying the various data compilations and so have generally relied on the accuracy of these secondary sources.

There are four significant differences between the data and analytical approach used by NMFS as compared with CDFG's (2002) status review. First, the NMFS analyzed data for all streams with some historical record of coho salmon presence, whereas CDFG restricted their analysis to those streams found on the Brown and Moyle (1991) list. Second, the NMFS database spans a slightly different time period: broodyears 1987 to 2001 (rather than 1986 to 2000). At the time these data were compiled, data from summer 2002 field surveys were only partially reported; thus, results from broodyear 2001 are preliminary. Third, unlike CDFG (2002), we did not infer presence in streams on the basis of occurrence in upstream tributaries. Although there is an intuitive logic to assigning presence to streams en route to a particular location, including these "inferred presence" values in the analysis tends to positively bias the overall estimate of percent occupancy because the same rationale for inference cannot be applied in the case of a recorded "absence." The magnitude of this bias on estimated occupancy rates for a given year depends on several factors including the proportion of streams sampled, the true occupancy rate for the year, and basin size, all of which effect how many inferences of presence can be made. And finally, in our analysis, we present summary information both by broodyear and by brood cycle (3-year aggregation). In contrast, in their broodyear analysis, CDFG (2002) calculated percent occupancy for 6-year time spans (two complete brood cycles); any observation of presence during that 6-year window resulted in a value of presence for the entire period.

Concerns have been expressed (CDFG 2003) about the validity of including certain streams cited as historical coho streams in various previously published status reviews. We have removed streams from our list that we have found to be in error, including those explicitly identified by CDFG as questionable. However, we have retained information provided by secondary sources in the absence of contradictory information. We have also compared our historical stream list with that developed by CDFG and have found that, although the NMFS stream list includes some streams not found on CDFG's list, most of these streams have limited if any data associated them. We estimate that observations associated with these streams constitute only about 1% of the more than 9,000 observations in the database, and the proportion of "presence" values in this subset is comparable to those observed for the entire dataset. Thus, even if some of these streams are found to be in error, their inclusion likely has minimal effect on estimated occupancy rates for the ESU.

Results for the NMFS presence-absence analyses are presented by major watersheds or aggregations of adjacent watersheds (Table C.2.2.3). In general, results from larger watersheds are presented independently, whereas data from smaller coastal streams, where data were relatively sparse, are grouped together. In a few cases, individual smaller coastal streams with only a few observations were aggregated with adjacent larger streams if there was no logical geographic grouping of smaller streams. We did not perform statistical analyses of temporal trends in estimated occupancy rates because of the substantial variation in the sampling methods and intensities represented in the dataset, both at the level of individual observations (e.g., index reaches versus whole stream surveys) and among years (i.e., changes in the number of streams surveyed or the principle survey methods through time). Fitting a statistical model to these data without better understanding of the underlying error structure would be of questionable value and would give an illusion of analytical rigor that is likely not supported by the underlying data.

Results—On an annual basis, the estimated percentage of streams in the SONCC for which coho salmon presence was detected has generally fluctuated between 36% and 61% between broodyears 1986 and 2000 (Figure C.2.2.1). Data that have been reported for the 2001 broodyear suggest a strong year class, as indicated by an occupancy rate of more than 75%; however, the number of streams for which data have been reported is small compared to previous years. The data suggest that, for the period of record, occupancy rates in the SONCC were highest (54-61%) between broodyears1991 and 1997, and then declined between 1998 and 2000 (39-51%) before rebounding in 2001. The pattern is similar whether all historical coho streams or just those identified in Brown and Moyle (1991) are considered (Figure C.2.2.1).

When data were aggregated over complete brood cycles (3-year periods), the percentage of streams for which coho salmon presence was detected remained relatively constant (between 60% and 67%) between the 1987-1989 and 1996-1998 brood cycles (Table C.2.2.3). Percent occupancy for the 1999-2001 brood cycle was lower at 46%; however, interpretation of this apparent decline is complicated by two factors. First, the number of streams surveyed was higher than in any other period due to CDFG's intensive survey of the Brown and Moyle streams in the summer of 2001, a drought year. Second, reporting from the 2002 summer season (broodyear 2001) remains incomplete, and as noted above, preliminary data indicate that the 2001 broodyear was strong. Thus, it is likely that the percent occupancy for this period will increase after all data from CDFG's 2002 survey and other sources are analyzed. When analysis was restricted to streams on the Brown and Moyle (1991) list, the ESU-wide pattern was almost identical, with percent occupancy values being within 1%-2% for all time periods (data not shown). Overall, it appears that, although there is considerable year-to-year variation in estimated occupancy rates, there has been no dramatic change in the percent of coho salmon streams occupied from the late 1980s and early 1990s to the present.

Table C.2.2.3. Percent of surveyed streams within the SONCC ESU for which coho salmon were detected for four time intervals: broodyears 1987-1989, 1990-1992, 1993-1995, 1996-1998, and 1999-2001. Streams include those for which historical or recent evidence of coho salmon presence exists. Based on NMFS and CDFG data (excluding inferred presences in CDFG data).

		1987-1989			**1990-1992**			**1993-1995**			**1996-1998**			**1999-2001**		
County and River Basins	Number of Streams with Historical Presence	Number Surveyed[1]	Coho Present[2]	Coho Absent[3]	Number Surveyed[1]	Coho Present[2]	Coho Absent[3]	Number Surveyed[1]	Coho Present[2]	Coho Absent[3]	Number Surveyed[1]	Coho Present[2]	Coho Absent[3]	Number Surveyed[1]	Coho Present[2]	Coho Absent[3]
Del Norte (includes OR tributaries)																
Illinois River	9	0	-	-	2	100%	0%	2	50%	50%	7	100%	0%	4	75%	25%
Smith River-Winchuck River	57	20	20%	80%	19	42%	58%	45	53%	47%	28	32%	68%	44	43%	57%
Klamath River -Trinity River	210	128	66%	34%	127	72%	28%	139	68%	32%	135	62%	38%	133	55%	45%
Humboldt																
Redwood Creek	23	10	80%	20%	10	100%	0%	19	79%	21%	13	92%	08%	19	84%	16%
Stone/Big Lagoons	5	1	0%	100%	2	100%	0%	1	0	100%	2	50%	50%	5	20%	80%
Litte River - Strawberry Creek	9	8	100%	0%	9	100%	0%	6	100%	0%	5	100%	0%	6	83%	17%
Mad River	23	8	100%	0%	7	86%	14%	7	86%	14%	9	78%	22%	22	64%	36%
Humboldt Bay tributaries	48	20	95%	5%	16	94%	6%	32	97%	3%	17	88%	12%	24	63%	37%
Eel River	221	109	47%	53%	126	59%	41%	132	58%	42%	59	31%	69%	151	30%	70%
Bear River-Guthrie Creek	5	0	-	-	0	-	-	3	0%	100%	2	0%	100%	4	0%	100%
Mattole River-McNutt Gulch	56	5	60%	40%	11	36%	64%	21	71%	29%	42	79%	21%	41	37%	63%
ESU Total	666	309	60%	40%	329	67%	33%	407	66%	34%	319	60%	40%	453	45%	55%

[1] Total number of steams surveyed at least once within the three-year interval

[2] Percentage of surveyed streams where coho were present in one or more years during the interval

[3] Percentage of surveyed streams where coho were absent in all years of survey during the interval

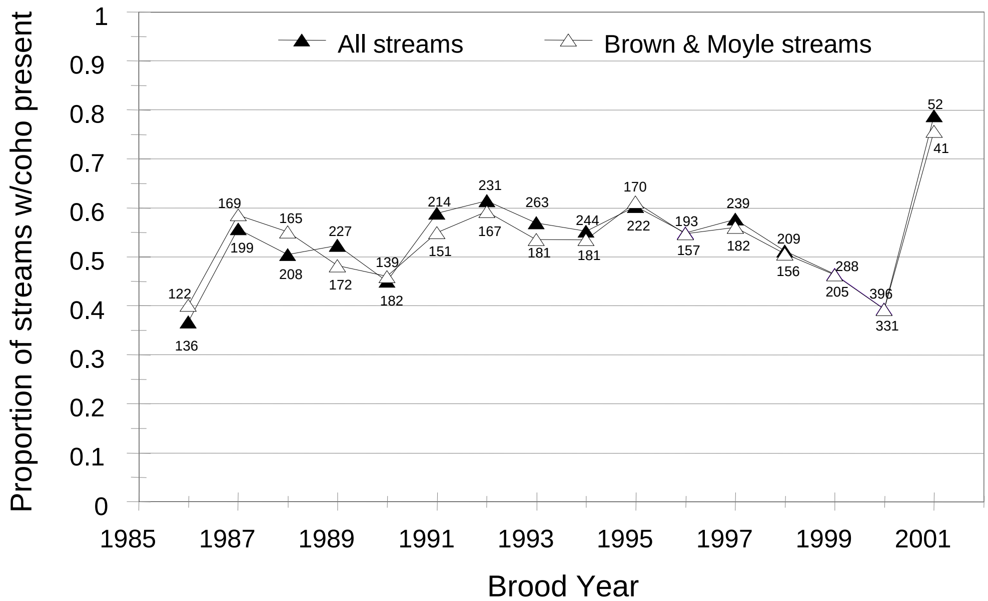

Figure C.2.2.1. Percent of streams surveyed for which coho salmon presence was detected, by broodyear, for all historical coho streams (solid triangles) and coho streams identified in Brown and Moyle's (1991) historical list (open triangles) within the SONCC ESU. Sample sizes (i.e. number of streams surveyed) are shown next to data points. Data are from combined NMFS and CDFG datasets (excluding inferred presence values in the CDFG data).

In general, the proportion of streams sampled within any individual watershed (or grouping of watersheds) was sufficiently small or variable among time periods to make interpretation of local trends difficult. The most notable exception was the Eel River, which showed occupancy rates declining from between 48% and 58% in the period between 1987 and 1995 to about 30% in the past two brood cycles. Similarly, the percentage of streams with coho salmon presence in the Klamath-Trinity system appears to have declined over the five brood cycles examined, though the magnitude of the decline is smaller: from between 66% and 71% in 1987 to 1995 to 62% and 55% in the past two brood cycles. In both cases, reporting from the 2001 broodyear is incomplete, and anecdotal reports suggest that inclusion of more data from the 2002 sampling year (2001 broodyear) may increase the observed percentages because of the relatively strong adult returns in the winter of 2001-2002. Thus, these apparent declines should be interpreted with caution. Still, the relatively low percentage of streams that still support coho salmon in the Eel River and the possible downward trend in the Klamath River basin, despite continued heavy hatchery influence, are cause for concern given that these are the largest river basins in the California portion of the SONCC and, if historical estimates are accurate (Table C.2.2.1), once accounted for well over half of the coho salmon produced in the California portion of the SONCC ESU.

The results of NMFS analysis are generally consistent with those of CDFG (2002), both suggesting a general decline in occupancy rates in from the late 1980s and early 1990s to the end of the 1990s, the significance of which remains somewhat uncertain because of non-systematic collection of presence-absence information and variation in sampling intensity (i.e., the number streams surveyed) through the period. NMFS (2001b) suggested that declines in percent occupancy in the SONCC from 1989 to 2000 were significant; however, the addition of new data makes us more cautious in this interpretation. Though the trend remains apparent, the magnitude of change is less than the previous data indicated. A more exhaustive examination of stream surveys from the SONCC region compiled by CDFG has substantially increased the total number of observations in the dataset (especially in the earliest years) and those additional observations have been strongly weighted toward "absences." Regardless, there is no evidence suggesting that occupancy rates have increased since the original status review for SONCC coho salmon was published in 1995.

Adult time series

Reliable current time series of naturally produced adult migrants or spawners are not available for SONCC ESU rivers. Spawner surveys have been conducted annually by the California Department of Fish and Game on 4.5 miles of Sprowl Creek, tributary to the Eel River, since 1974 (except in 1976-1977) and on 2 miles of Cannon Creek, tributary to the Mad River, since 1981 (PFMC 2002b). However, these surveys are conducted primarily to generate minimum chinook counts and the likelihood of detecting coho salmon is influenced strongly by the frequency of sampling and environmental conditions (i.e., turbidity) during those surveys (CDFG 2003). Spawner surveys have been conducted by Jim Waldvogel (UC Cooperative Extension, unpublished data) on the West Branch Mill Creek, a tributary to the Smith River, from 1980 to 2001. Peak live/dead counts have fluctuated between 2 and 28 fish during this period, again making their use for trend analysis inappropriate. Surveys have also been conducted on the West Branch (4.7 miles) and East Branch (5.4 miles) of Mill Creek by Stimson Timber Company since 1993. Maximum live/dead counts recorded by Stimson on the West Branch averaged 62 fish between 1993 and 1996, declining to an average of 4 fish between 1997 and 2000. On East Branch, maximum live/dead counts averaged 32 fish between 1993 and 1996, declining to an average of 6 fish between 1997 and 2000 (Howard 1998; Paul Albro, Stimson Lumber Company, unpublished data). Howard (1998) notes that the reliability of these counts varies with flow conditions.

Juvenile time series

Methods—Juvenile density estimates have been made during summer at seven index sites within the Eel River basin over the past 8 to 18 years: Upper Indian Creek, Moody Creek, Piercy Creek, Dutch Charlie Creek, and Redwood Creek in the South Fork Eel River basin (Steven Levesque and David Wright, Campbell Timberland Management, unpublished data); and two sites on Hollow Tree Creek in the Middle Fork Eel Basin (Scott Harris, CDFG, unpublished data). We performed an analysis of juvenile density to determine whether such patterns observed in juveniles are consistent with those observed in the analysis of presence-absence information.

To estimate a trend, data were log-transformed and then normalized so that each data point was expressed as a deviation from the mean of that specific time series. The normalization was intended to prevent spurious trends that could arise from different methods of data collection. Following transformation, time series were aggregated, based on watershed structure, into groups thought to plausibly represent independent populations. Linear regression was used to estimate trends (i.e., slopes) for each aggregate dataset. Analysis was restricted to 1) sites where a minimum of 8 years of data were available, and 2) putative populations where more than 65% of the observations were non-zero values.

Results—Aggregate trends were estimated separately for the South Fork Eel River and Middle Fork Eel River sites. In both cases, trends were positive, but not significantly different from 0 (South Fork: slope 0.053, 95% CI from -.074 to 0.180; Middle Fork: slope 0.016, 95% CI from -0.051 to 0.180).

Oregon populations

One effect of the OCSRI has been increased monitoring of salmon and habitats throughout the Oregon coastal region. Besides continuation of the abundance data series analyzed in the 1997 status update, Oregon has expanded its random survey monitoring to include areas south of Cape Blanco, including monitoring of spawner abundance, juvenile densities, and habitat condition.

Spawner abundance—In the Oregon portion of the ESU, spawner abundance is monitored only in the Rogue River Basin. Other small coastal basins have limited coho salmon habitat, and are not thought to have sustainable local coho salmon populations (Jacobs et al. 2002). Within the Rogue Basin, two methods are used to monitor adult abundance: beach-seine surveys conducted at Huntley Park in the upper estuary, and stratified-random spawning ground surveys (Jacobs et al. 2002). The Huntley Park seine estimates provide the best overall assessment of both naturally produced and hatchery coho salmon spawner abundance in the basin (Figure C.2.2.3). Spawner survey-based abundance estimates are also available for the basin since 1998, when the surveys were expanded south of Cape Blanco. These estimates are consistently lower than the seine-based estimates, which may be due in part to losses during upstream migration (Jacobs et al. 2002); however, ODFW considers the seine-based estimates to be more accurate as an overall assessment of spawner abundance (S. Jacobs, ODFW, pers. comm. October 2002). The spawning-ground surveys allow examination of the distribution of spawners among subbasins: in 2001, the majority of spawners were in main tributaries (Illinois and Applegate Rivers and Evans and Little Butte Creeks).

The occurrence of hatchery fish in natural spawning areas is also a consideration for the productivity of the natural population. Roughly half of the total spawning run in the Rogue River Basin is hatchery fish; however, many of these fish return to Cole Rivers Hatchery, rather than spawning in natural habitat. Based on fin-mark observations during spawning-ground surveys, the average percent of natural spawners that are of hatchery origin has ranged from less than 2% (2000) to nearly 20% (1998) in recent years. These hatchery spawners are largely concentrated in the mainstem tributaries, with very few hatchery fish observed in major tributaries (Jacobs et al. 2002).

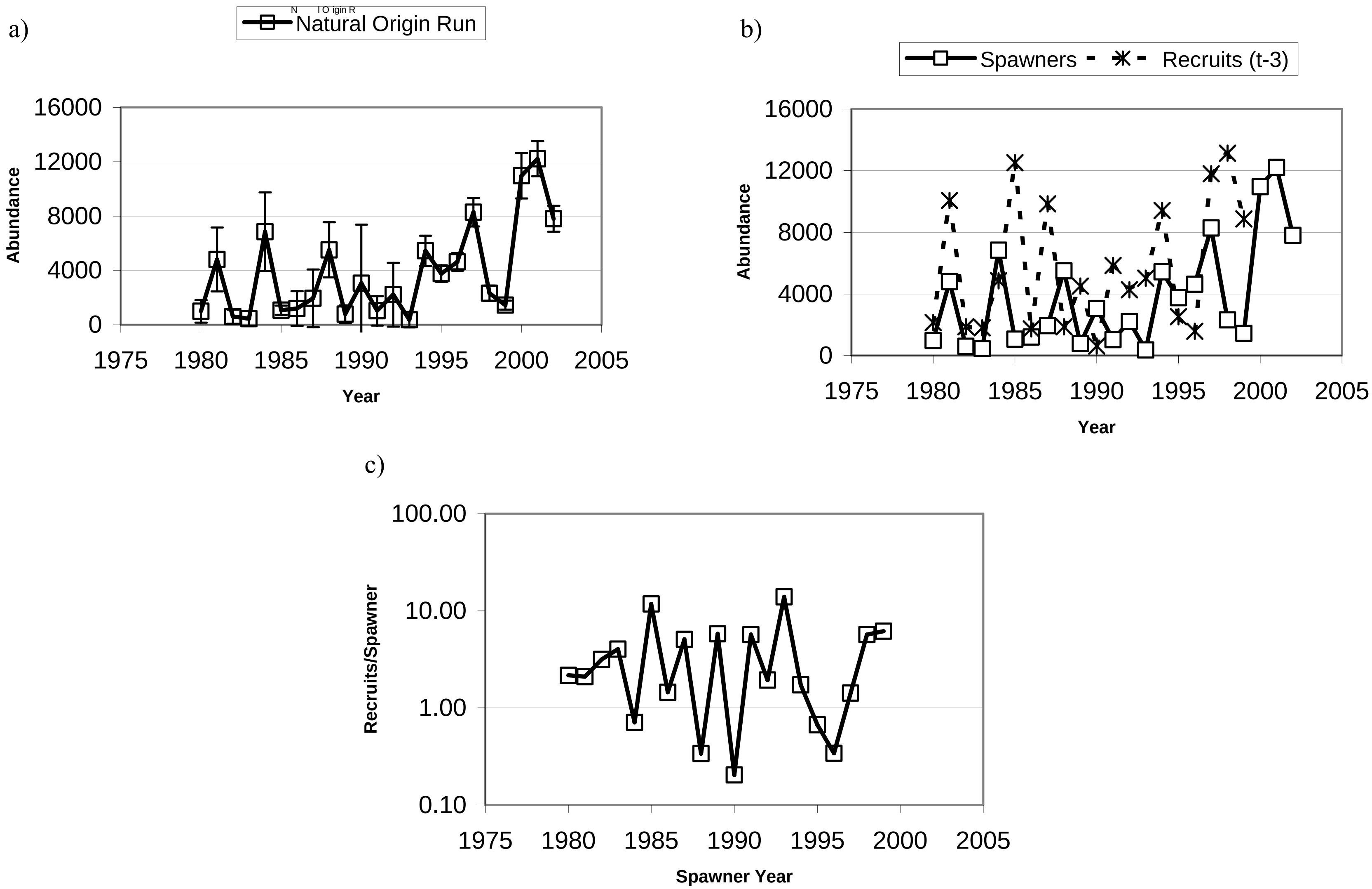

Figure C.2.2.3. Trends in Rogue River coho salmon populations, based on ODFW surveys at Huntley Park (Jacobs et al. 2002). a) Natural spawner abundance with 95% confidence interval; b) Pre-harvest recruits and spawner abundance; c) Recruits (lagged 3 years) per spawner (note logarithmic scale).

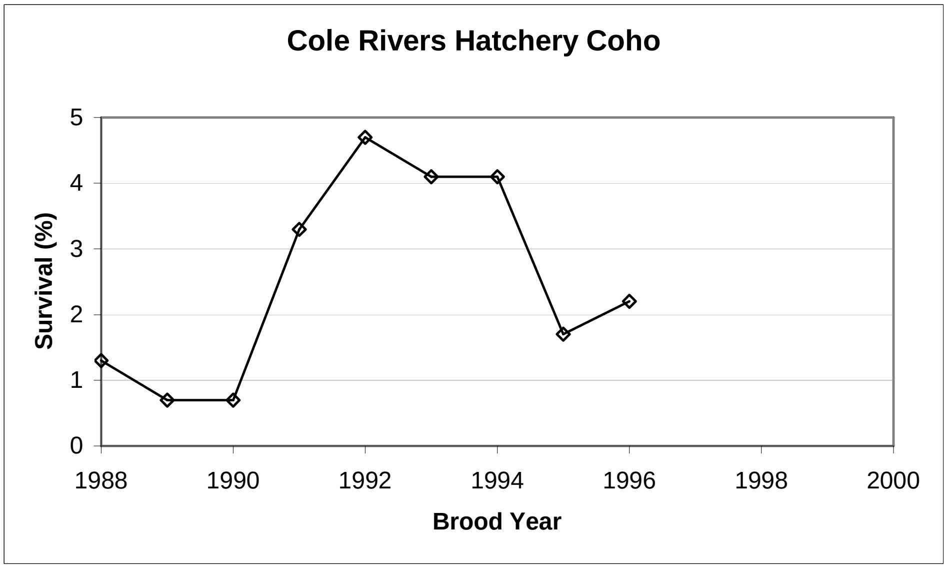

Figure C.2.2.4. Percent survival of CWT-marked coho salmon from Cole Rivers Hatchery, calculated from data in Lewis (2002).

Results—Mean spawner abundance and trends for Rogue River coho salmon are given in Table C.2.2.4. (Note that because estimates of hatchery-origin fish on the spawning ground are not available for most years, lambda was not computed for this population.) Both short- and long-term trends in naturally produced spawners are upward; however, this increasing trend in spawners results largely from reduced harvest, as trends in pre-harvest recruits are smaller (Figure C.2.2.3, Table C.2.2.4). Recruits per spawner fluctuate widely, with little apparent trend (Figure C.2.2.3). Fluctuations in naturally produced spawner abundance are generally in phase with survival of hatchery fish (Figure C.2.2.4), suggesting that ocean conditions play a large role in population dynamics. Note that hatchery-fish survival for the Rogue River stock is generally higher and follows a different pattern than the general OPI survival index (see Oregon Coast ESU discussion).

Juvenile density—Regular monitoring of juvenile coho salmon in the Oregon portion of the SONCC ESU began in 1998, and 4 years of data are currently available, as reported in Rodgers (2002). Several statistics are reported, including percent occupancy and mean density. Methods differ from the California surveys reported above, so direct comparison of results is problematic. The most comparable statistic to the California presence/absence data is "percentage of sites with at least one pool containing coho," which has been steadily increasing from about 30% in 1998 to 58% in 2001; this compares with a range of 52% to 80% for other parts of the Oregon coast. Percentage of pools per site containing coho salmon has also increased, reaching 41% (s.e. 4.9%) in 2001. Mean juvenile density has also increased over the 3 years. In 2001, overall mean density of juveniles in surveyed pools was 0.38 fish per square meter (fish·m^{-2}); this compares with a range of 0.27 to 0.50 fish·m^{-2} for other areas of the Oregon coast.

Table C.2.2.4 Abundance and trend estimates for Rogue River Basin coho salmon natural spawners, estimated from Huntley Park seine data (Jacobs et al. 2002) from 1980 to 2001. Shown are the most recent geometric mean (along with minimum and maximum values for the data series) and trend estimates for spawners and recruits, both long- and short-term, along with the probability that the true trend is decreasing.

Parameter	Value	95% C.I.	P(decrease)
Recent spawner abundance			
Last 3 years geometric mean	10147		
Last 3 years arithmetic mean	10326		
Last 3 years range	7800-12213		
Spawner Trend			
Short-term (1990-2002)	1.16	(1.01, 1.34)	0.02
Long-term (1980-2002)	1.08	(1.01, 1.15)	0.01
Pre-Harvest Recruit Trend			
Short-term (1990-2002)	1.08	(.94, 1.25)	0.12
Long-term (1980-2001)	1.02	(0.95, 1.08)	0.27

Habitat condition—The Oregon Plan Habitat Survey (OPHS) began in 1998, as part of the ODFW Aquatic Inventories Project begun in 1990. Information here is derived from the Survey's year 2000 report (Flitcroft et al. 2001). The survey selects 500-m to 1,000-m sites along streams according to a spatially balanced random selection pattern. The survey includes both summer and winter habitat sampling. In addition to characterization of the site's streamside and upland processes, specific attributes sampled are: large wood, pools, riparian structure, and substrate. The program has established benchmark thresholds as indicators of habitat quality:

- Pool area greater than 35% of total habitat area;
- Fine sediments in riffle units less than 12% of all sediments;
- Volume of large woody debris greater than 20 m^3 per 100 m stream length;
- Shade greater than 70%;
- Large riparian conifers more than 150 trees per 305 m stream length.

For the combined 1998-2000 surveys in the Oregon portion of the SONCC ESU, 6% of sites surveyed met none of the benchmarks, 29% met one, 38% met two, 20% met three, 5% met four, and 2% met all five benchmarks. No trends in habitat condition can yet be assessed from this data, but it will provide a basis for future assessment of changes in habitat quality.

C.2.2.3 New Comments

The Siskiyou County Farm Bureau (2002) submitted comments arguing that SONCC coho salmon should not be protected under ESA, particularly because the relationship of Iron Gate Hatchery fish in the Klamath River to the SONCC ESU remains uncertain. Their principal arguments is that widespread historical outplanting of juvenile coho salmon and incorporation of non-native fish into hatchery broodstock make application of the ESU concept inappropriate; they argue that all West Coast coho salmon should be considered a single ESU.

The Siskiyou Project submitted comments supporting continued listing of coho salmon in the SONCC under ESA (Siskiyou Project 2002). They argue that 1) the status of native, naturally reproducing coho salmon in the SONCC remains unchanged since they were listed in 1997; 2) increases in adult coho salmon observed in 2001 and 2002 are mostly due to improved ocean conditions and reduced harvest, and are not indicative of long-term trends; 3) severe drought in the winter 2001-2002 and summer 2001 are likely to result in lower smolt production in spring 2002 and adult returns in 2003; 4) habitat already in poor condition is likely to deteriorate with increasing human demands for natural resources and inadequate regulations; and 5) continued large releases of hatchery coho salmon pose a threat to naturally produced fish through competition, mixed-stock fishing, and reduced fitness associated with interbreeding of hatchery and wild fish. The Siskiyou Project also included a report authored by Cindy Deacon Williams, private consultant, titled *Review of the status of Southern Oregon/Northern California coho with thoughts on recovery planning targets*. Ms. Williams' report presents basin-by-basin assessments of the status of coho salmon (using primarily previously published analyses), habitat conditions, and ongoing activities that pose risks to coho salmon. She also recommends numeric recovery criteria for SONCC coho salmon and argues that habitat targets are needed to ensure recovery.

The Douglas County Board of Commissioners submitted a report, *Viability of coho salmon populations on the Oregon and northern California coasts*, submitted to NMFS Protected Resources Division on 12 April 2002 and prepared by S.P. Cramer and Associates, Inc. (Cramer and Ackerman 2002). This report analyzes information available for both the Oregon Coastal Coho Salmon ESU and the SONCC ESU in several areas: trends in abundance and distribution, trends in survival, freshwater habitat condition, potential hatchery-wild interactions, changes in harvest regulation, and extinction risk modeling. Little of the information presented in the report is specific to the SONCC ESU. They cite changes in fishery management, increasing spawning escapements, reduced hatchery releases, habitat restoration, and evidence of successful rearing of fry outmigrants throughout the Oregon Coast, some information for the Rogue River basin, but no new information for California populations.

Daniel O'Hanlon (2002a,b), attorney at law, submitted comments on two occasions on behalf of Save Our Shasta and Scott Valley Towns (S.O.S.S), an organization of citizens concerned about the effects of ESA regulations. The latter submission includes comments submitted to the California Fish and Game Commission regarding the petition to list coho salmon in Northern California under the state Endangered Species Act, which include, by reference, a critique of CDFG's (2002) status review prepared by Dr. Charles Hanson. Though the critique is of the state's analysis of coho status, some the arguments are germane to the federal status review since the underlying data are comparable. The essential arguments from this collection of documents are 1) the limited data presented in the initial status reviews was insufficient to assess, in a scientifically rigorous way, the degree of extinction risk facing coho salmon in the SONCC; 2) there is no evidence of an immediate or near-term risk of extinction based on analysis of either presence-absence data or abundance trend data; presence-absence data have a number of weaknesses, and historical trend data (abundance and harvest) are unreliable; and 3) existing regulatory structures are adequate to protect coho salmon; new regulations would hinder, rather than help coho recovery.

The Yurok Tribal Fisheries Program (2002) submitted recent data from various sampling efforts in the lower Klamath River and its tributaries. Included were data from downstream migrant traps, adult snorkel surveys, tribal harvest, and harvest catch-per-unit effort. Data on relative contribution of naturally produced and hatchery fish to tribal harvest and to catch at the lower Klamath and lower Trinity downstream migrant trapping sites are discussed in the section on New Hatchery/ESU Information below. Other data were incorporated into NMFS presence-absence analysis discussed above. None of the time series available met the minimum criterion of 8 years, which was decided upon by the BRT as the minimum needed for trend analysis.

C.2.2.4 New Hatchery Information

Weitkamp et al. (1995) identified four hatcheries that were producing and releasing coho salmon within the SONCC ESU during the mid 1990s: Mad River Hatchery, Trinity River Hatchery, Iron Gate Hatchery, and Cole Rivers Hatchery. Prairie Creek hatchery produced coho salmon for many years, but closed in 1992 (CDFG 2002). Rowdy Creek hatchery is a privately owned hatchery that has produced coho salmon in the past; however, the facility did not produce coho salmon in 1999 and 2000 due to lack of adult spawners (CDFG 2002), and no further production of coho salmon at this facility is planned (Andrew VanScoyk, Rowdy Creek Hatchery, pers. comm.).

Iron Gate Hatchery—Iron Gate Hatchery (IGH), located on the Klamath River near Hornbrook, California, approximately 306 km from the ocean, was founded in 1965 and is operated by the California Department of Fish and Game (CDFG). The hatchery was built by Pacific Power and Light Company to mitigate effects of the Iron Gate Project on wild salmonids, including coho salmon, that naturally occurred in the upper Klamath River (CDFG 2002; SHHAG 2003). The IGH coho stock was developed initially from eggs taken from Klaskanine Hatchery in Oregon, via Trinity River Hatchery in 1966. In an effort to increase returns to Iron Gate Hatchery, coho salmon from Cascade River (Columbia River) were released in 1966, 1967, 1969, and 1970 (CDFG 2002; CDFG 2003). Since 1977, only Klamath Basin fish have been released from IGH (CDFG 2003).

Annual releases of coho salmon from IGH have decreased from an average of approximately 147,000 fish from 1987-1991 to about 72,000 fish from 1997-1999 (Table C.2.2.5); this reduction in releases reflects effort on CDFG's part to more closely adhere to the IGH mitigation goal of 75,000 yearlings released per year. Adult returns averaged 1,120 fish between 1991 and 2000, and an average of 161 females have been spawned annually during this period.

The CDFG and NMFS Southwest Region Joint Hatchery Review Committee (2001) noted that no accurate estimates of the relative contribution of naturally produced vs. hatchery fish are available for the Klamath River basin. Beginning in 1995, coho salmon released from IGH have been marked with left maxillary clips; however, return information has been published for only a single year, 2000. These data indicate that 80% of 1,353 fish returning to IGH were marked hatchery fish, with 98% being Iron Gate releases. A few fish from the Trinity and Cole Rivers (Rogue River, Oregon) hatcheries were also taken. The significance of this high percentage of hatchery fish with respect to total production in the Klamath Basin is uncertain since IGH lies near the upper end of the accessible habitat.

Table C.2.2.5. Average annual releases of coho salmon juveniles (fry and smolts) from selected hatcheries in the SONCC coho salmon ESU during release years 1987-1991, 1992-1996, and 1997-2002. Hatchery classification assigned by Salmon and Steelhead Hatchery Assessment Group (SHHAG 2003) is also shown.

Hatchery	SSHAG Category	Average Annual Releases 1987-1991	1992-1996	1997-2002
Cochran Ponds (HFAC)		35,391[a]	na[b]	0[b]
Mad River[c]	4	372,863	91,632	82,129[d]
Prairie Creek		89,009[e]	0[f]	0[f]
Trinity River[g]	2b	496,813	385,369	527,715
Iron Gate (Klamath)[h]	2c	147,272	92,150	71,932[i]
Rowdy Creek[j]		0	12,534[k]	10,615[l]
Cole Rivers (Rogue)[m]	2a	271,492	239,534[n]	270,344[o]
Total		1,413,380	821,685	1,007,391

[a] Average from 2 years (1987-1988). Source: Weitkamp et al. 1995.
[b] Coho salmon were produced by the Humboldt Fish Action Council (HFAC) through the 1994 broodyear; release data for 1992 to 1996 are currently unavailable; no fish were released after 1996 (S. Holz, HFAC, pers. comm.)
[c] Sources: Weitkamp et al. 1995; Gallagher 1993-1995; Cartwright 1996-2001
[d] CDFG ceased spawning coho salmon at Mad River Hatchery in 1999; yearling were last released in 2001
[e] Average from 4 years (1987-1988, 1990-1991). Source: Weitkamp et al. 1995.
[f] Prairie Creek hatchery ceased producing coho salmon in 1992.
[g] Sources: Ramsden 1993-2002.
[h] Sources: Hiser 1993-1996; Rushton 1997-2002.
[i] Does not include releases from year 2002 (data not available)
[j] Source: A. Van Scoyk, Rowdy Creek Hatchery, unpublished data.
[k] Average from 2 years (1995-1996); data not available for 1992-1995.
[l] Rowdy Creek hatchery ceased releasing coho in year 2001.
[m] Source: Bill Waknitz, NMFS, pers. comm.
[n] Average from 1991-1995.
[o] Average from 1996-2002; includes juvenile coho salmon released to lakes.

Additional information about the composition of Klamath Basin stocks is available from tribal harvest and downstream migrant trap data collected by the Yurok Tribal Fisheries (2002).

Between 1997 and 2000, tribal harvest of coho salmon ranged from 42 to 135 fish and then increased to 895 in 2001. During this five-year period, hatchery fish constituted between 63% and 86% of the total fish harvested. Iron Gate Hatchery fish generally made up a small (8% or less) fraction of total hatchery fish captured, the exception being in 1997, when they constituted about 37% of the hatchery fish caught. In contrast, Trinity River Hatchery fish accounted for 87% to 95% of hatchery fish harvested in 1998-2001, and 40% of the hatchery fish captured in 1997.

In 1997 and 1998, Yurok Tribal Fisheries operated a downstream migrant trap in the lower Klamath River, below the confluence of the Klamath and Trinity rivers; thus the trap captured fish from both the Iron Gate and Trinity hatcheries. During 2 years of sampling, Trinity hatchery fish dominated the total catch accounting for 73% and 83% of all fish caught in 1997 and 1998, respectively. Iron Gate Hatchery fish accounted for around 5% of the catch in both years. Naturally produced coho salmon made up 22% of the total catch in 1997 and 12% of the catch in 1998. In 1998, a second trap was operated on the lower Trinity River. Only 9% of the smolts captured at this trap were naturally produced. Assuming that this proportion accurately reflected the relative contributions of naturally produced and hatchery Trinity River fish to catch at the Lower Klamath trap, then the percentages of naturally produced and hatchery fish exiting the Klamath River proper (above the Trinity confluence) were approximately 42% and 58%, respectively.

In previous status reviews, the BRT was uncertain about whether the use of non-native stocks to start the Iron Gate population was of sufficient importance to have lasting effects on the present population. Thus, they reached no conclusion about whether the hatchery stock should be included in the ESU (NMFS 1997). Subsequently, Iron Gate was determined to be a Category 2 hatchery (SSHAG 2003). For other SSHAG hatchery stock categorizations, see Appendix C.5.1.

Trinity River Hatchery—Trinity River Hatchery (TRH), located below Lewiston Dam approximately 248 km from the ocean, first began releasing coho salmon in 1960. The TRH facility originally used Trinity River fish for broodstock, though coho salmon from Eel River (1965), Cascade River (1966, 1967, and 1969), Alsea River (1970), and Noyo River (1970) have also been reared and released at the hatchery as well as elsewhere in the Trinity Basin.

Trinity River Hatchery produces the largest number of coho salmon of any production facility in California. CDFG's annual production target is 500,000 yearlings. Actual production averaged 496,813 from 1987-1991, decreased to 385,369 from 1992-1996, and then increased again to 527,715 fish from 1997-2002 (Table C.2.2.5). During the period 1991-2001, an average of 3,814 adult coho were trapped and 562 females were spawned at the TRH.

It is commonly assumed that there is little production of wild coho salmon in the Trinity River system, and available data generally support this assumption. Between 1997 and 2002, hatchery fish constituted between 89% and 97% of the fish (adults plus grilse) returning to the Willow Creek weir in the lower Trinity River (Sinnen 2002). Outmigrant trapping conducted on the lower Trinity River indicates that marked TRH fish made up 91%, 97%, and 65% of the catch in years 1998, 1999, and 2000, respectively (Yurok Tribal Fisheries 2002). Additionally, it appears that a significant fraction of the naturally produced fish are likely the progeny of hatchery strays. By subtracting the number of hatchery and naturally produced fish returning to TRH from counts at Willow Creek weir, Sinnen (2002) estimated that hatchery fish made up between 76% and 96% of fish that spawned within the Trinity River system upstream of the weir from 1997 to 2002. A potential source of bias in these estimates is that fact that Willow Creek weir typically washes out prior to the end of the coho adult migration season. There is some suggestion that wild Trinity River coho salmon return later in the season than TRH fish, which would result in an overestimate of hatchery contribution to spawning in the wild (George Kautsky, Hoopa Valley Tribal Fisheries, pers. comm.); however, there are no data by which to assess whether such bias exists. Additionally, we are aware of no information from which to assess 1) the degree to which TRH fish that pass over the weir are straying into various sub-basins within the Trinity River (Hoopa Valley Tribe 2003), or 2) whether hatchery and wild fish have an equal probability of successfully spawning in the wild.

The BRT concluded that coho salmon from the Trinity River Hatchery should be considered part of the SONCC ESU since out-of-basin and out-of-ESU transfers ceased by 1970 and production since that time has been exclusively from fish within the basin. The lack of natural production within the Trinity Basin, however, remains a significant concern. The Trinity Hatchery is a Category 2 hatchery (SSHAG 2003).

Mad River Hatchery—Mad River Hatchery (MRH), located approximately 20 km upriver near the town of Blue Lake, first began producing coho salmon in 1970. The original broodstock (1970) was from the Noyo River, which lies outside of the SONCC ESU, and Noyo fish were released from the hatchery during 12 additional years between 1971 and 1996. Other stocks released from the hatchery include out-of-ESU transfers from the Trask River (1972), Alsea River (1973), Klaskanine River (1973), Green River (1979), and Sandy River (1980), as well as out-of-basin, within-ESU transfers from the Trinity River (1971), Klamath River (1981, 1983, 1986-1989), and Prairie Creek (1988, 1990).

Releases of Mad River fish declined substantially during the past decade, from an average of 372,8643 fish in 1987-1991 to just over 82,000 in the period from 1997-2001 (Table C.2.2.5). Production of coho salmon at MRH ceased after broodyear 1999, thus, the year 2001 releases represent the final year of hatchery production. Adult returns were low during the 1990s, with an average of 38 adults trapped and 16 females spawned during the period between 1991 and 1999. No information was available regarding the relative contribution of naturally produced and artificially propagated fish within the Mad River basin. However, concern about both out-of-ESU and out-of-basin stock transfers, as late as 1996, was sufficiently great that the Mad River Hatchery was excluded from the SONCC ESU by NMFS (1997). This conclusion has been rendered moot by the decision to cease producing coho salmon at the Mad River facility.

Rowdy Creek Hatchery—Rowdy Creek Hatchery is a privately owned hatchery in the Smith River Basin constructed in 1977. Production emphasis has been on chinook and steelhead, but small numbers of coho salmon were trapped and bred during the period 1990 to 1998. Only local coho salmon broodstock have been used at the Rowdy Creek facility (NMFS 1997).

Annual releases of coho salmon yearlings averaged 12,534 between 1995 and 1996, and 15,923 from 1997 to 2000, when releases were terminated (Table C.2.2.5). Adult returns to the hatchery averaged just 26 fish in the 11 years that coho salmon were trapped (A. Van Scoyk, Rowdy Creek Hatchery, unpublished data). No information was available on the relative contribution of Rowdy Creek Hatchery coho salmon to the Smith River population as a whole, but it was undoubtedly a minor component during the period of operation.

In its status review update, the BRT (NMFS 1997) concluded that the Rowdy Creek Hatchery population should be considered part of the ESU, but that it was not essential for ESU recovery. This conclusion has been rendered moot by the decision to cease producing coho salmon at the facility.

Cole Rivers Hatchery—The Cole Rivers Hatchery has raised Rogue River (Oregon stock #52) coho salmon since 1973 to mitigate for lost production due to construction of Lost Creek Dam. This stock was developed from local salmon trapped in the river, and has no history of out-of-basin fish being incorporated. Recent releases (1996-2002) have averaged 270,000 per year, compared to a 1991-1995 average of 240,000 per year (Table C.2.2.5); the increase is due to inclusion in the data of large-sized coho salmon released to lakes in the basin in recent years (Bill Waknitz, NMFS, pers. comm.). Spawning of hatchery fish in nature is essentially limited to mainstem tributaries and (to a lesser extent) the Applegate River, and interbreeding with natural fish is limited by separation in spawning time (Jacobs et al. 2002). The hatchery is rated as a Category 1 hatchery (SSHAG 2003).

Summary

Artificial propagation of coho salmon within the SONCC has been substantially reduced in the past 8 to 10 years, with the exception of Cole Rivers Hatchery on the Rogue River and the Trinity River Hatchery. Annual releases from the Cole Rivers and Trinity hatcheries have recently averaged 270,000 and 528,000 fish, respectively. Production has ceased at one major facility (Mad River), as well as well as several minor facilities (Rowdy Creek, Eel River, and Mattole River). Production at Iron Gate Hatchery on the Klamath River has been reduced by approximately 50%. Genetic risks associated with out-of-basin and out-of-ESU stock transfers have largely been eliminated. However, two significant genetic concerns remain: 1) the potential for domestication selection in hatchery populations such as Trinity River, where there is little or no infusion of wild genes, and 2) out-of-basin straying by large numbers of hatchery coho.

Harvest impacts

Historically, ocean harvest of SONCC coho salmon has occurred in coho- and chinook-directed commercial and recreational fisheries off the coasts of California and Oregon. Significant changes in harvest management have occurred since the late 1980s, which have resulted in substantial reductions in ocean harvest of SONCC coho salmon. In establishing fishing seasons and regulations each year, the Pacific Fishery Management Council (PFMC) considers the potential impacts on various ESA-listed stocks within the region. Because there are no data on exploitation rates on wild SONCC coho salmon, Rogue and Klamath River (RK) hatchery stocks are used as a fishery surrogate stock for estimating exploitation rates on SONCC coho. The PFMC estimates that most ocean harvest of RK coho salmon (and presumably SONCC coho salmon) occurs south of Humbug Mountain, Oregon, which lies near the northern boundary of the SONCC ESU.

During the 1970s and early 1980s, commercial fishing seasons for coho salmon south of Humbug Mountain generally lasted from four to five months or more (PFMC 2003). These seasons were substantially shortened in the late 1980s and early 1990s, particularly between

Humbug Mountain and Point Arena, California due to changes in allocation fall chinook salmon to tribal and non-tribal fall fisheries in the Klamath Management Zone. Retention of coho salmon in ocean commercial fisheries south of Cape Falcon, Oregon, has been prohibited since 1993 (PFMC 2002b). In 1994, retention of coho salmon in ocean recreational fisheries was prohibited from Cape Falcon south to Horse Mountain, California, and this prohibition was extended to include all California waters in 1995. The retention prohibition has remained in effect south of Humbug Mountain since that time.

Mass-marking (adipose fin clips) of hatchery coho salmon throughout much of the Oregon Production Index area has led to the implementation of mark-selective recreational fisheries for hatchery fish along portions of the coast north of Humbug Mountain beginning in 1998 and continuing through 2002. Marked fish may be legally retained, while unmarked fish must be released unharmed. SONCC-origin coho salmon that migrate north of Cape Blanco experience incidental morality due to hooking and handling in this fishery; however, total incidental mortality from this fishery and chinook-directed fisheries north of Humbug Mountain has been estimated to be less than 7% of the total mortality of RK hatchery coho salmon since 1999 (PFMC 1999-2003).

In 1999, NMFS issued a biological opinion establishing a consultation standard requiring that overall annual ocean exploitation rate not exceed 13% on RK stocks. To conform to this standard, the Pacific Fishery Management Council (PFMC) adopted fishing seasons in 1999-2002 for which the projected coastwide marine exploitation rate on RK stocks ranged between 3.0 and 7.7%. During that time, an estimated 93% to 97% of this mortality has occurred in chinook-directed fisheries south of Humbug Mountain (PFMC 1999-2003).

Estimates of ocean exploitation rates on SONCC coho salmon for years prior to their listing under ESA are not available. Harvest estimates for various landing ports in California are available dating back to the early 1950s and indicate that annual harvest in the commercial fishery ranged averaged about 163,000 between 1952 and 1991 (PFMC 2003). Between 1962 and 1993, recreational harvest in California averaged about 34,000 fish. In both cases, these totals represent fish a mixture of fish both naturally produced and hatchery fish originating from Oregon and California. Neither escapement estimates nor estimates of the contribution of SONCC fish to total harvest, from which exploitation rates could be derived, are available. However, there is no doubt that ocean exploitation rates have dropped substantially in response to the non-retention regulations put in place in 1994 as well as general reductions in chinook-directed effort.

Directed river harvest of coho salmon has not been allowed within the SONCC ESU since 1994, with the exception of sanctioned tribal harvest for subsistence, ceremonial, and commercial purposes by the Yurok, Hoopa Valley, and Karuk tribes (CDFG 2002). Harvest data are only available for the Yurok Tribe (2002), which reports that annual harvest of coho salmon from reservation lands on the lower Klamath River has averaged 244 fish (67% marked hatchery fish) between 1997 and 2001, though this average is strongly influenced by a harvest of almost 900 fish in 2001. In the other four years, harvest did not exceed 135 fish. Mortality associated with incidental or illegal catch of naturally produced coho salmon in SONCC rivers is uncertain, but believed to be low (CDFG 2002).

C.2.2.5 Comparison with Previous Data

New data for the SONCC coho salmon ESU includes expansion of presence-absence analyses, a limited analysis of juvenile abundance in the Eel River basin, a few indices of spawner abundance in the Smith, Mad, and Eel river basins, and substantially expanded monitoring of adults, juveniles, and habitat in southern Oregon. None of these data contradict conclusions reached previously by the BRT. Nor do any of recent data (1995 to present) suggest any marked change, either positive or negative, in the abundance or distribution of coho salmon within the SONCC ESU. Coho salmon populations continued to be depressed relative to historical numbers, and there are strong indications that breeding groups have been lost from a significant percentage of streams within their historical range. Although the 2001 broodyear appears to be the one of the strongest perhaps of the last decade, it follows a number of relatively weak years. The Rogue River stock is an exception; there has been an average increase in spawners over the last several years, despite 2 low years (1998, 1999).

Risk factors identified in previous status reviews, including severe declines from historical run sizes, the apparent frequency of local extinctions, long-term trends that are clearly downward, and degraded freshwater habitat and associated reduction in carrying capacity continue to be of concern to the BRT. Termination of hatchery production of coho salmon at the Mad River and Rowdy Creek facilities has eliminated potential adverse risk associated with hatchery releases from these facilities. Likewise, restrictions on recreational and commercial harvest of coho salmon since 1994 have undoubtedly had a substantial positive impact on coho salmon adult returns to SONCC streams. An additional risk factor that has been identified within the SONCC ESU is predation resulting from the illegal introduction of non-native Sacramento pikeminnow (*Ptychocheilus grandis*) to the Eel River basin (NMFS 1998). Sacramento pikeminnow were introduced to the Eel River via Pillsbury Lake in the early 1980s and have subsequently spread to most areas within the basin. The rapid expansion of pikeminnow populations is believed to have been facilitated by alterations in habitat conditions (particularly increased water temperatures) that favor pikeminnow (Brown et al. 1994; NMFS 1998).

C.2.3 CENTRAL CALIFORNIA COAST COHO SALMON

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C.2.3.1 Previous BRT Conclusions

The Central California Coast (CCC) coho salmon Evolutionarily Significant Unit extends from Punta Gorda in Northern California south to and including the San Lorenzo River in Central California (Weitkamp et al. 1995). The status of coho salmon throughout their West Coast range, including the CCC ESU, was formally assessed in 1995 (Weitkamp et al. 1995). Two subsequent status review updates with information pertaining to the CCC ESU were published by NMFS in 1996 (NMFS 1996a, b). Analyses from those reviews regarding extinction risk, risk factors, and hatchery influences is summarized in the following sections.

Status indicators and major risk factors

Data on abundance and population trends of coho salmon within the CCC ESU were limited. Historical time series of spawner abundance for individual river systems were unavailable. Brown et al. (1994) presented several historical point estimates of coho salmon spawner abundance (excluding ocean catch) for the entire state of California for 1940 and for various rivers and regions in the early 1960s and mid 1980s (Table C.2.3.1). Coho salmon were estimated to number between 200,000 and 500,000 statewide in the 1940s (E. Gerstung, CDFG, pers. comm., cited in Brown et al. 1994). Coho salmon spawning escapement was estimated to have declined to about 99,400 fish by the mid-1960s, with approximately 56,100 (56%) originating from streams within the CCC ESU (Table C.2.3.1). In the mid-1980s, spawning escapement was estimated to have dropped to approximately 30,480 in California and 18,050 (59%) within the CCC ESU. Employing the “20-fish rule” (see status review update for Southern OR-Northern CA Coast coho salmon for details), Brown et al. (1994) estimated wild and naturalized coho salmon populations at 6,160 (47% of the statewide total) for the CCC ESU during the late 1980s (Table C.2.3.1). All of these estimates are considered to be “best guesses” based on a combination of limited catch statistics, hatchery records, and personal observations of local biologists (Brown et al. 1994).

Further information regarding status was obtained from Brown et al.’s (1994) analysis of recent (1987-1991) occurrence of coho salmon in streams historically known to support populations. Of 133 historical coho salmon streams in the CCC ESU for which recent data were available, 62 (47%) were determined to still support coho runs while 71 (53%) apparently no longer support coho salmon (Table C.2.3.2). A subsequent analysis of surveys from 1995-1996 found a somewhat higher (57%) percentage of occupied streams (NMFS 1996b, based on pers. comm. with P. Adams, NMFS Southwest Fisheries Science Center).

Nehlsen et al. (1991) provided no specific information on individual coho salmon populations in their 1991 status review, but concluded that salmon stocks in small coastal streams north of San Francisco were at moderate risk of extinction and those in coastal streams south of San Francisco Bay were at high risk of extinction. A subsequent status review by the

Humboldt Chapter of the American Fisheries Society (Higgins et al. 1992) found four populations (Pudding Creek, Garcia River, Gualala River, and Russian River) to be at high risk of extinction and five (Ten Mile, Noyo, Big, Navarro, and Albion rivers) as stocks of concern.

Table C.2.3.1. Historical estimates of coho salmon spawner abundance for various rivers and regions within the Central California Coast Evolutionarily Significant Unit.

	Estimated Escapement		
	CDFG (1965)[a]	**Wahle & Pearson (1987)[b]**	**Brown et al. (1994)[c]**
River/Region	**1963**	**1984-1985**	**1987-1991**
Ten Mile River	6,000	2,000	160[d]
Noyo River	6,000	2,000	3,740
Big River	6,000	2,000	280
Navarro River	7,000	2,000	300
Garcia River	2,000	500	
Other Mendocino County	10,000	7,000[e]	470[f]
Gualala River	4,000	1,000	200
Russian River	5,000	1,000	255
Other Sonoma County	1,000		180
Marin County	5,000		435
San Mateo & Santa Cruz Counties	4,100	550	140
San Mateo County	1,000		
Santa Cruz County (excl. San	1,500	50	
San Lorenzo River	1,600	500	
ESU Total	56,100	18,050	6,160
California Statewide Total[e]	99,400	30,480	13,240

[a] Values excludes ocean catch.
[b] Estimates are for wild or naturalized fish; hatchery returns excluded.
[c] Estimates are for wild or naturalized fish; hatchery returns excluded. For streams without recent spawner estimates (or estimates lower than 20 fish), assumes 20 spawners.
[d] Indicates high probability that natural production is by wild fish rather than naturalized hatchery stocks.
[e] Value may include Marin and Sonoma County fish.
[f] Appears to include Garcia River fish.
[g] Estimated number of coho salmon for CCC ESU and California portion of the SONCC ESU combined.

Risk factors identified by the BRT included extremely low contemporary abundance compared to historical abundance, widespread local extinctions, clear downward trends in abundance, extensive habitat degradation, and associated decreases in carrying capacity. Additionally, the BRT concluded that the main stocks of coho salmon in the CCC ESU have been heavily influenced by hatcheries and that there were relatively few native coho salmon left in the ESU (Weitkamp et al. 1995). Most existing stocks have a history of hatchery planting, with many out-of-ESU stock transfers. A subsequent status review (NMFS 1996a), which focused on existing hatcheries, concluded that, despite the historical introduction of non-native fish, the Scott Creek (Kingfisher Flat) and Noyo River broodstocks have regularly incorporated wild broodstock and, thus, were unlikely to differ from naturally spawning fish within the ESU. Recent droughts and unfavorable ocean conditions were identified as natural factors contributing to reduced run size.

Table C.2.3.2. Historical presence of coho salmon in the CCC ESU, as determined by Brown et al. (1994) and the California Department of Fish and Game's analysis of recent presence (1995-2001). County classifications are based on the location of the mouth of the river system. Data from CDFG (2002). Note that methods for estimating occupancy rates differed between Brown et al. (1994) and CDFG (2002); thus, direct comparisons across time periods are inappropriate.

	Brown et al. (1994) Calendar years 1987-1990				**CDFG (2002) Years 1995-2001**				
County/River Basin	**no. of streams**	**no. of streams w/info.**	**coho present**	**%**	**no. of streams surveyed in 2001**	**no. of streams w/coho present**	**no. of streams w/coho assumed present**	**no. of streams w/coho not detected in 2001**	**Percent present (1995-2001)**
Mendocino Co.									
Coastal	44	35	13	37%	30	11	10	19	52%
Ten Mile River	11	10	7	79%	11	9	0	2	82%
Noyo River	13	12	11	92%	8	7	5	1	92%
Big River	16	13	11	85%	8	3	6	5	64%
Navarro River	19	8	4	50%	14	6	1	8	47%
Subtotal	103	78	46	59%	71	36	22	35	62%
Sonoma County									
Coastal	10	2	1	50%	4	0	0	4	0%
Gualala River	11	2	1	50%	10	0	0	10	0%
Russian River	32	24	2	8%	29	1	1	28	0%
Subtotal	53	28	4	14%	43	1	1	42	4%
Marin County									
Coastal[a]	10	7	7	100%	15	6	0	9	40%
Subtotal	10	7	7	100%	15	6	0	9	40%
Tribs. to S.F. Bay									
Coastal	7	7	0	0%	0	0	0	0	0%
Subtotal	7	7	0	0%	0	0	0	0	0%
South of S.F. Bay									
Coastal	13	13	5	38%					
Subtotal	13	13	5	38%					
ESU Total	186	133	62	47%	135	43	23	92	42%

[a] CDFG (2002) included five tributaries of Salmon Creek, a Sonoma County stream that empties into Tomales Bay, in their totals for Marin County.

Previous BRT conclusions

Based on the data presented above, the BRT concluded that all coho salmon stocks in the CCC ESU were depressed relative to historical abundance and that most extant populations have been heavily influenced by hatchery operations. They unanimously concluded that natural populations of coho salmon in this ESU were in danger of extinction (Weitkamp et al. 1995). After considering new information on coho salmon presence within the ESU, the majority of the BRT concluded that the ESU was in danger of extinction, while a minority concluded the ESU was not presently in danger of extinction but was likely to become so in the foreseeable future (NMFS 1996b).

Listing status

Coho salmon in the CCC ESU were listed as threatened in October 1996.

C.2.3.2 New Data and Updated Analyses

Significant new information on recent abundance and distribution of coho salmon within CCC ESU has become available, much of which has been summarized in two recent status reviews (NMFS 2001b; CDFG 2002). Most of these data are of two types: 1) compilations of presence-absence information for coho salmon throughout the CCC during the period 1987 to the present, and 2) new data on densities of juvenile coho salmon collected at a number of index reaches surveyed by private timber companies, CDFG, and other researchers. Excepting adult counts made at the Noyo Egg Collecting Station, which are both incomplete counts and strongly influenced by hatchery returns, there are no current time series of adult abundance within this ESU that span 8 or more years. Outmigrating smolts have been trapped at two trapping facilities in Caspar Creek and Little River since the mid-1980s; however, these are partial counts and only recently have mark-recapture studies been performed that allow correction for capture efficiency at these two sites. Thus, these smolt counts can only be considered indices of abundance.

Two analyses of presence-absence data have recently been published. CDFG (2002) performed an analysis that focused on recent (1995-2001) presence of coho salmon in streams identified as historical producers of coho salmon by Brown and Moyle (1991). NMFS (2001b) published an updated status review that analyzed coho salmon presence in streams throughout the CCC during the period 1989 to 2000. Scientists at NMFS' Southwest Fisheries Science Center have continued to compile information of coho salmon presence-absence and have incorporated data into a database that is now summarized by broodyear (rather than year of sampling) and covers broodyears 1986-2001. Data from CDFG's 2001 field survey of the Brown and Moyle (1991) streams has been incorporated into this database. Analyses presented in the present status review update supercede those presented in NMFS (2001b).

CDFG presence-absence analysis

Methods—Methods used by CDFG (2002) for analyzing presence-absence information in the CCC differed from those used for the SONCC analysis. Analysis focused on results from

CDFG's 2001 summer juvenile sampling effort in which 135 of 173 streams identified by Brown and Moyle (1991) as historical coho salmon streams within the CCC ESU were sampled. Additionally, CDFG assumed presence of coho salmon in any stream for which presence had been detected during any 3 consecutive years during the period 1995-2001. An estimate of percent coho salmon presence was calculated by totaling the number of streams for which presence was either observed or assumed, and dividing by the total number of streams surveyed, inclusive of those where presence was assumed. No formal statistical analysis of trends was performed because of the lack of comparable data from previous time periods.

Results—For the CCC ESU as a whole, CDFG (2002) estimated that coho salmon were present in 42% of streams historically known to contain coho salmon. Estimated occupancy was highest in Mendocino County (62%), followed by Marin County (40%), Sonoma County (4%), and San Francisco Bay tributaries (0%) (Table C.2.3.2). Because of differences in the specific streams considered and methods for estimating occupancy rates, these numbers are not directly comparable with those derived by Brown et al. (1994). Nevertheless, the regional and overall ESU patterns are generally concordant for the two studies, indicating substantial variation in occupancy rates across the ESU with lower occupancy rates in the southern portion of the ESU (Table C.2.3.2).

NMFS presence-absence analysis

Methods—Scientists at NMFS' Southwest Fisheries Science Center compiled survey information from streams with historical or recent evidence of coho salmon presence within the CCC ESU. Data were provided primarily by the California Department of Fish and Game, private landowners, consultants, academic researchers, and others who have conducted sampling within the CCC during the years 1988 to 2002. The majority of data come from summer juvenile surveys, though information from downstream migrant trapping and adult spawner surveys were also included. Observations of presence or absence for a particular stream were assigned to the appropriate broodyear based on the life stages observed (or expected in the case of absences). The resulting dataset spans broodyears 1987 to 2001, though data from the 2002 summer field season (broodyear 2001) were not fully reported at the time the analysis was performed.

Results for NMFS' presence-absence analysis are presented by major watersheds or aggregations of adjacent watersheds. Results from larger watersheds are typically presented independently, whereas data from contiguous smaller coastal streams, where data were relatively sparse, are grouped together. In a few cases, individual smaller coastal streams with only a few observations were aggregated with adjacent larger streams if there was no logical geographic grouping of smaller streams.

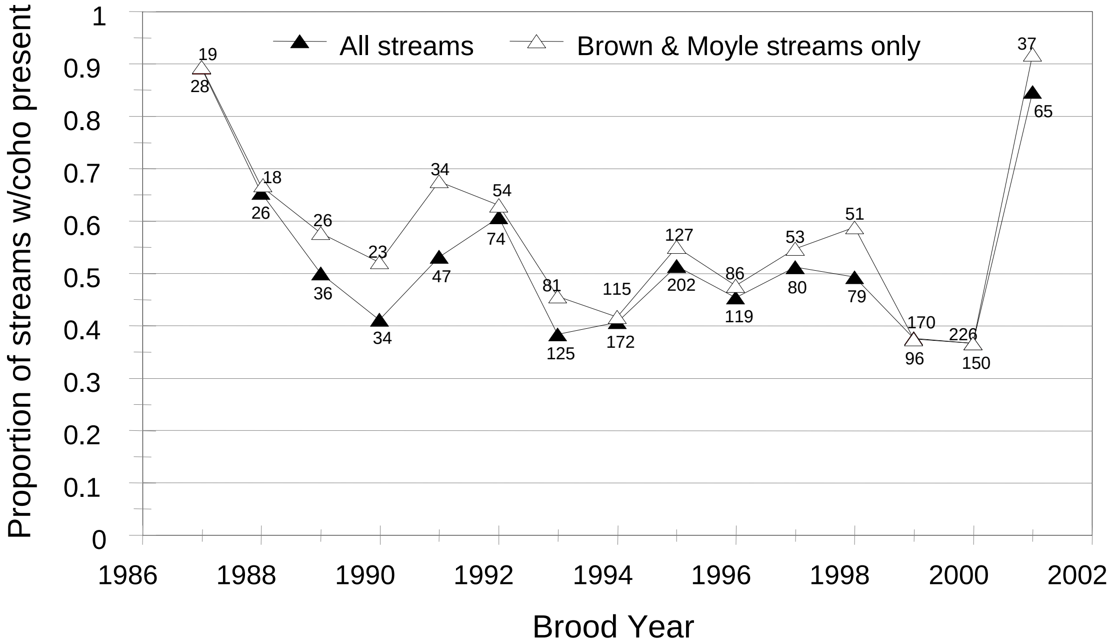

Figure C.2.3.1. Percent of streams surveyed for which coho salmon presence was detected, by broodyear, for all historical coho streams (solid triangles) and coho streams identified in Brown and Moyle's (1991) historical list (open triangles) within the CCC ESU. Sample sizes (i.e. number of streams surveyed) are shown above next to data points. Data are from combined NMFS and CDFG datasets.

Results—The estimated percentage of streams in which coho salmon were detected shows a general downward trend from 1987 to 2000, followed by a substantial increase in 2001 (Figure C.2.3.1). Several caveats, however, warrant discussion. First, the number of streams surveyed per year also shows a general increase from 1987 to 2000; thus, there may be a confounding influence of sampling size if sites surveyed in the first half of the time period are skewed disproportionately toward observations in streams where presence was more likely. Second, sample size from broodyear 2001 was relatively small and the data were weighted heavily toward certain geographic areas (Mendocino County and systems south of the Russian River). The data for broodyear 2001 included almost no observations from watersheds from the Navarro River to the Russian River, or tributaries to San Francisco Bay, areas where coho salmon have been scarce or absent in recent years. Thus, while 2001 appears to have been a relatively strong year for coho salmon in the CCC as a whole, the high percentage of streams where presence was detected shown in Figure C.2.3.1 is likely inflated.

Two other patterns were noteworthy. First, compared with percent presence values for the SONCC ESU, values in the CCC were more highly variable and showed a somewhat more cyclical pattern. In general, percent occupancy was relatively low in broodyears 1990, 1993, 1996, and 1999, suggesting that this brood lineage is in the poorest condition. In contrast, during the 1990s, percent occupancy tended to be high in broodyears 1992, 1995, 1998, and 2001, suggesting that this is the strongest brood lineage of the three. Second, there is a general tendency for percent occupancy to be slightly higher (2%-15%) for the Brown and Moyle streams compared with the ESU as a whole. We speculate that this pattern may reflect the fact that increased concern over CCC coho salmon in the mid-1990s prompted increased sampling of streams in the CCC, including streams other than those traditionally known to support coho salmon. Lower occupancy rates at these sites might be expected if they represent habitats that are generally less suitable for coho salmon.

When data are aggregated over brood cycles (3-year periods), the percentage of streams with coho salmon detected shows a similar downward trend, from 72% in 1987-1989, to 62% in 1990-1992, to less than 55% in the last three brood cycles (Table C.2.3.3). Again there are confounding influences of increased sampling fraction through time and incomplete reporting for the 2001 broodyear. Nevertheless, it appears that the percent of historical streams occupied continued to decline from the late 1980s to the mid-1990s and remains below 50% for the ESU as a whole. Additionally, coho salmon appear to be extinct or nearing extinction in several geographic areas including the Garcia River, the Gualala River, the Russian River, and San Francisco Bay tributaries. There is also evidence that some populations that still persist in the southern portion of the range, including Waddell and Gazos creeks, have lost one or more brood lineages (Smith 2001).

Results from our presence-absence analysis are generally concordant with CDFG's analysis. The two studies show consistent regional patterns suggesting that within the CCC the proportion of streams occupied is highest in Mendocino County, but that populations in streams in the southern portion of the range (excluding portions of Marin County) have suffered substantial reductions in range. NMFS analysis is more suggestive of a continued decline in percent occupancy from the late 1980s to the present; however, increased sampling in recent years may be confounding any trends.

Adult time series

No time series of adult abundance free of hatchery influence and spanning 8 or more years are available for the CCC ESU. Adult counts from the Noyo Egg Collecting Station (ECS) dating back to 1962 represent a mixture of naturally produced and hatchery fish, and counts are incomplete most years because trap operation was sporadic during the season and typically ceased after broodstock needs were met. Thus, at best they represent an index of abundance. Assuming that these counts reflect general population trends, there appears to have been a significant decline in abundance of coho salmon in the South Fork Noyo River beginning in 1977 (Figure C.2.3.2). No formal analysis of trends was conducted because of the uncertainty of the relationship between catch statistics and population size, as well as the relative contribution of hatchery fish to total numbers during the entire period of record.

Smolt time series

California Department of Fish and Game personnel have trapped outmigrating smolts at Caspar Creek and Little River since 1986. These counts are partial counts, uncorrected for capture efficiency. As such, they provide only indices of abundance. However, they likely capture gross changes in smolt abundance over the years (Figure C.2.3.3). For Caspar Creek, the highest smolt counts occurred in the late 1980s and early 1990s, decreased in the mid-1990s, and then increased in the past three years to levels approaching those of the late 1980s (Figure C.2.2.3). For Little River, a similar pattern was observed from the late-1980s to the mid-1990s;

Table C.2.3.3. Percent of surveyed streams within the CCC ESU for which coho salmon were detected for four time intervals: broodyears 1987-1989, 1990-1992, 1993-1995, 1996-1998, and 1999-2001. Streams include those for which historical or recent evidence of coho salmon presence exists (based on combined NMFS and CDFG data).

		1987-1989			1990-1992			1993-1995			1996-1998			1999-2001		
County and River Basins	**Number of Streams with Historical Presence**	**Number Surveyed[a]**	**Coho Present[b]**	**Coho Absent[c]**	**Number Surveyed[a]**	**Coho Present[b]**	**Coho Absent[c]**	**Number Surveyed[a]**	**Coho Present[b]**	**Coho Absent[c]**	**Number Surveyed[a]**	**Coho Present[b]**	**Coho Absent[c]**	**Number Surveyed[a]**	**Coho Present[b]**	**Coho Absent[c]**
Mendocino																
Coastal (Punta Gorda to Abolabodiah Cr.)	24	4	75%	25%	6	50%	50%	16	50%	50%	11	18%	82%	19	32%	68%
Ten Mile River	25	6	50%	50%	15	53%	47%	17	65%	35%	14	57%	43%	16	94%	6%
Pudding Cr. to Noyo River	43	4	75%	25%	8	88%	12%	35	66%	34%	15	80%	20%	38	68%	32%
Coastal (Hare Cr. to Russian Gulch)	14	8	100%	0%	4	100%	0%	9	67%	33%	9	67%	33%	4	75%	25%
Big and Little Rivers	28	5	20%	80%	7	57%	43%	20	75%	25%	16	81%	19%	16	38%	62%
Albion River	16	3	100%	0%	3	100%	0%	15	80%	20%	1	100%	0%	14	86%	14%
Little Salmon & Big Salmon Cr.	6	0	-	-	3	100%	0%	4	75%	25%	4	75%	25%	4	100%	0%
Navarro River	30	1	100%	0%	1	0%	100%	24	58%	42%	6	67%	33%	23	52%	48%
Coastal (Greenwood Cr. to Brush Cr.)	8	3	0%	100%	2	50%	50%	8	13%	87%	0	-	-	8	0%	100%
Garcia River to Digger Cr.	8	3	100%	0%	2	0%	100%	8	13%	87%	5	20%	80%	7	0%	100%
Sonoma																
Gualala River	15	1	100%	0%	1	0%	100%	11	0%	100%	1	0%	100%	11	9%	91%
Fort Ross to Russian River	55	5	40%	60%	14	50%	50%	37	54%	46%	29	24%	76%	37	11%	89%
Marin																
Tomales Bay Rivers	25	3	100%	0%	4	100%	0%	14	36%	64%	10	90%	10%	21	57%	43%
Coastal (Redwood Cr. to Bolinas Lagoon)	6	0	-	-	1	100%	0%	2	50%	50%	4	75%	25%	5	100%	0%
San Francisco Bay																
SF Bay Rivers	6	0	-	-	4	0%	100%	6	0%	100%	4	0%	100%	0	-	-
San Mateo/Santa Cruz																
Coastal (SF Bay to Aptos Creek)	17	7	100%	0%	7	100%	0%	13	69%	31%	14	57%	43%	12	67%	33%
Monterey																
Coastal (Carmel R. to Big Sur R.)	2	0	-	-	0	-	-	2	0%	100%	0	-	-	2	0%	100%
ESU Total	**328**	**53**	**72%**	**28%**	**82**	**63%**	**37%**	**241**	**54%**	**46%**	**143**	**54%**	**46%**	**237**	**48%**	**52%**

[a] Total number of steams surveyed at least once within the three-year interval

[b] Percentage of surveyed streams where coho were present in one or more years during the interval

[c] Percentage of surveyed streams where coho were absent in all years of survey during the interval

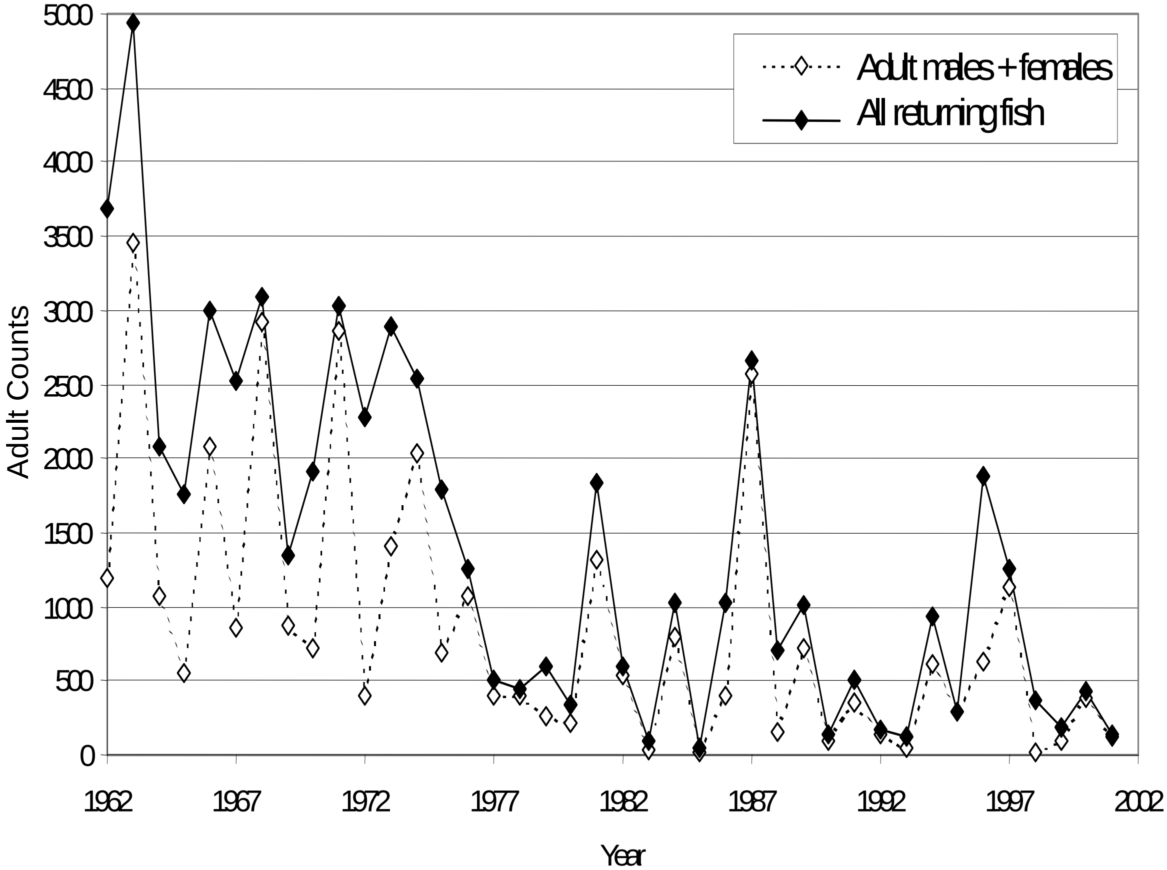

Figure C.2.3.2. Counts of adult coho salmon at Noyo Egg Collecting Station from 1962 to 2002. Solid line with closed symbol indicates total fish captured (including grilse); dashed line with open symbols indicates adult males and females only. Counts are partial counts and thus are only a crude index of adult abundance. Data source: Grass 2002.

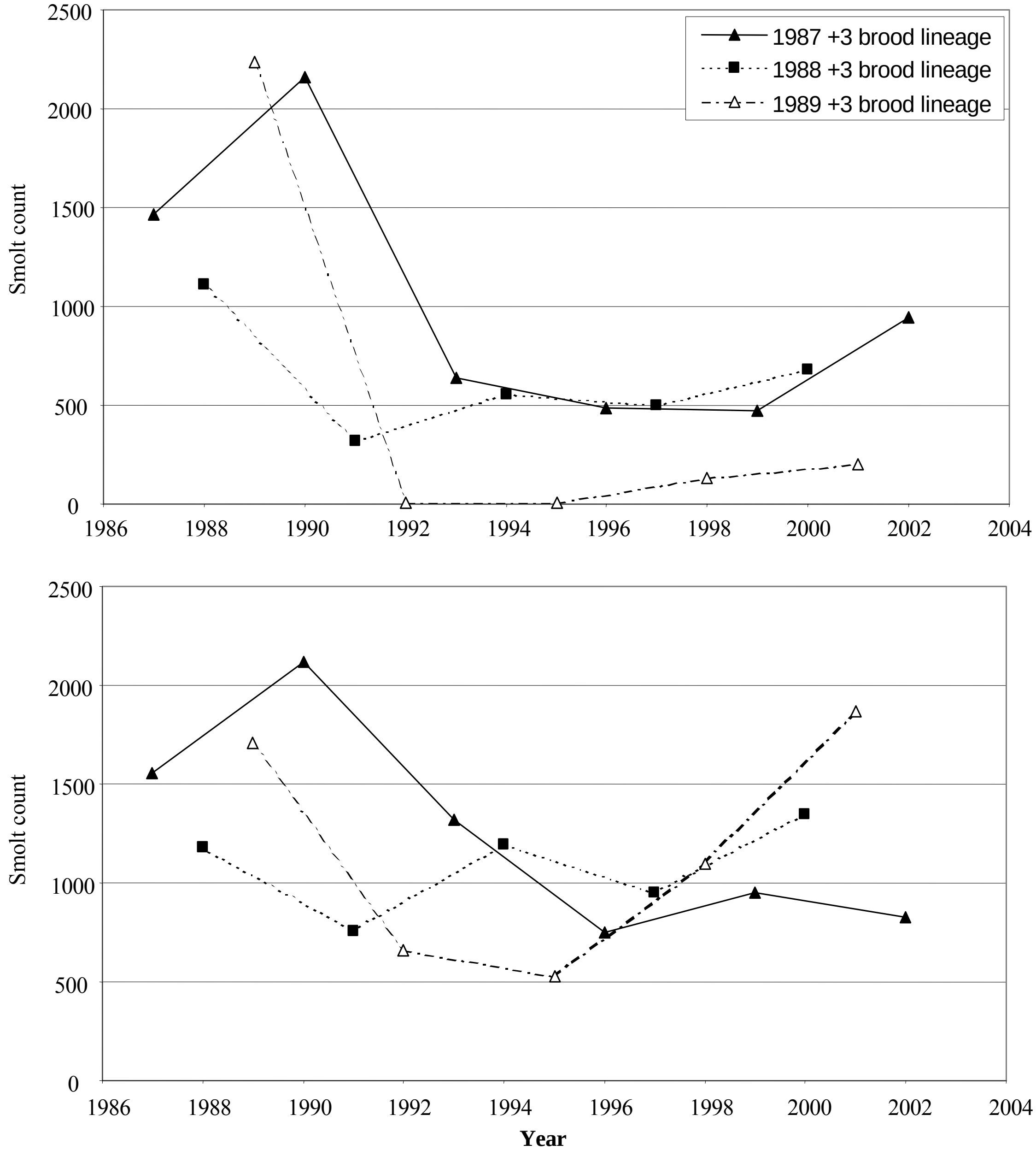

Figure C.2.3.3. Coho salmon smolt counts at a) Little River and b) Caspar Creek, Mendocino County. Lines track brood lineages. Data are counts of smolts uncorrected for trap efficiency and thus should be viewed as coarse indices of abundance. Data source: Scott Harris, CDFG, unpublished data.

Table C.2.3.4. Population trend analysis for Caspar Creek and Little River smolt outmigrant data. Trends are based on smolt counts uncorrected for trap efficiency (see text). Data source: Scott Harris, CDFG, unpublished data.

	Geometric Means[a]				
Stream	Recent 3-year mean	3-year min.	3-year max.	Lambda[b]	Long-term trend[b]
Caspar Cr.	1,278 (829-1,871)	723 (530-953)	1,383 (1,182-2,121)	1.002 (0.851, 1.178)	-0.017 (-0.081, 0.048)
Little R.	504 (198-946)	94 (4-640)	1,750 (1,111-2,161)	0.919 (0.669, 1.347)	-0.063 (-0.358, 0.232)

[a] Values parentheses for geometric means are the range of values observed over the three-year period.

[b] Values in parentheses for lambda and trends are lower and upper bounds for 95% confidence limits.

however, only a slight increase in numbers has been observed in the last three years of records. Smolt counts were higher in each year from 1986 to 1989 than in any year since (Figure C.2.2.3). When individual brood lineages are tracked, Little River shows a decline in all three brood lineages over the period of record. In contrast, Caspar Creek shows a decline in the 1987 brood lineage, relatively consistent numbers in the 1988 brood lineage, and a decrease in the early to mid-1990s followed by an increase over the last two brood cycles to levels comparable to those observed in 1989 (Figure C.2.2.3). For both locations, the estimated long-term trend is negative but not significantly different from 0 (Table C.2.3.4). Likewise, lambda values are not significantly different from 1.

Juvenile time series

Methods—While recent estimates of adult and smolt abundance are scarce for the CCC ESU, estimates (or indices) of juvenile density during summer have been made at more than 50 index sites within the CCC in the past 8 to 18 years. Methods for analyzing these data are described in detail in the SONCC coho salmon status review update. Briefly, data from individual sampling sites were ln-transformed and normalized to prevent spurious trends arising from different data collection methods or reporting units. Data were then grouped into units thought to represent plausible independent populations based on watershed structure. Trends were then estimated for putative populations by estimating the slope (and associated 95% confidence intervals) for the aggregated data. Analysis was restricted to 1) sites where a minimum of 6 years of data were available, and 2) putative populations where more than 65% of all observations were non-zero values.

Nine geographic areas (putative populations) were represented in the aggregated data including Pudding Creek, Noyo River, Caspar Creek, Big River, Little River, Big Salmon Creek, Lagunitas Creek, Redwood Creek, and coastal streams south of San Francisco Bay, including Waddell, Scott, and Gazos creeks. Spatially, these sites cover much of the CCC ESU; however, several key watersheds are not represented, including the Ten Mile, Navarro, Garcia, Gualala, and Russian Rivers. Although considerable sampling has been done in the Ten Mile River basin, the high proportion of zero values precluded analysis of these data.

Results—Overall, analysis of juvenile data provided little evidence of either positive or negative trends for the putative populations examined. Estimated slopes were negative for six populations and positive for three; however, none of the estimated slopes differed significantly from zero (Table C.2.3.5).

Table C.2.3.5. Trend slopes and confidence intervals for nine putative coho populations in the CCC ESU.

			95% confidence interval	
Watershed	**No. Sites**	**Aggregate Slope**	**Lower bound**	**Upper bound**
Pudding Creek	1	-0.019	-0.103	0.065
Noyo River	8	-0.091	-0.195	0.013
Caspar Creek	2	-0.039	-0.109	0.030
Little River	2	-0.044	-0.118	0.029
Big River	2	0.146	-0.001	0.293
Big Salmon Creek	5	-0.005	-0.110	0.100
Lagunitas Creek	3	0.095	-0.123	0.312
Redwood Creek	1	0.091	-0.345	0.527
Waddell/Scott/Gazos creeks	3	-0.111	-0.239	0.018

C.2.3.3 New Comments

Homer T. McCrary, vice president of Big Creek Lumber, submitted 375 pages comprised primarily of excerpts from historical documents related to operation of hatcheries in Santa Cruz County from the early 1900s to 1990. The expressed intent of this compilation was "to assist the efforts of resource professionals, scientists, regulators, fisheries restoration advocates and all interested parties in establishing a more complete historical perspective on salmonid populations." Quantitative information regarding hatchery and stocking histories is discussed in the Harvest Impact section.

C.2.3.4 New Hatchery Information

The BRT (Weitkamp et al. 1995) identified four production facilities that had recently produced coho salmon for release in the CCC ESU: the Noyo Egg Collecting Station (reared at Mad River Hatchery) and Don Clausen (Warm Springs) hatchery, both operated by CDFG; Big Creek Hatchery (Kingfisher Flat Hatchery), operated by the Monterey Bay Salmon and Trout Program; and the Silver-King ocean ranching operation. The latter facility closed in the late 1980s.

Noyo Egg Collecting Station—The Noyo Egg Collecting Station (ECS), located on the South Fork Noyo River approximately 17 km inland of Fort Bragg, began operating in 1961 and has collected coho salmon in all but a few years since that time. Fish have historically been reared at the Mad River Hatchery, Don Clausen (Warm Springs) Hatchery, and the Silverado Fish Transfer Station. There are no records of broodstock from other locations being propagated with Noyo fish for release back into the Noyo system, but a few out-of-ESU transfers directly into the Noyo system have been recorded, including Alsea and Klaskanine, OR stocks (SSHAG 2003).

Average annual release of coho salmon yearlings was 108,000 from 1987-1991 (Weitkamp et al. 1995), declined to about 52,000 between 1992 and 1996, and then increased again to about 72,000 fish between 1997 and 2002, inclusive of 2 years where no yearlings were released (Table C.2.3.6). Releases have been made exclusively to the ECS or elsewhere in the South Fork Noyo drainage in the past decade. Between 1991 and 2001, adult returns averaged 572 individuals, though these represent incomplete counts in most years, as counting typically ceased after broodstock needs were met (Grass 2002). On average, 91 females were spawned annually during this 11-year period (Grass 1992-2002).

There are no basin-wide estimates of natural and artificial production for the Noyo Basin as a whole; however, marking of coho salmon juveniles released from the Noyo ECS on the South Fork began in 1997, and returns have been monitored since the 1998-1999 spawning season. In the 1998, 1999, and 2000 broodyears, marked hatchery fish constituted 85%, 70%, and 80%, respectively, of returning adults captured at the ECS.

The BRT (NMFS 1996a) concluded that, although exotic stocks have occasionally been introduced into the Noyo system, the regular incorporation of local natural fish into the hatchery population made the likelihood that this population differs substantially from naturally spawning fish in the ESU is low and, therefore, included them in the ESU. Since CCC coho salmon were listed, no significant changes in hatchery practices have occurred. The Noyo ECS operation has been classified as a Category 1 hatchery (SSHAG 2003).

Don Clausen (Warm Springs) Hatchery—The Don Clausen Hatchery (a.k.a. Warm Springs stock), located on Dry Creek in the Russian River system 72 km upstream of the mouth, began operating in 1980. Initial broodstock used were from the Noyo River system, and Noyo fish were planted heavily from 1981 to 1996.

Average annual releases of coho salmon from the hatchery decreased from just over 123,000 in the 1987-1991 period to about 57,000 in the years between 1992 and 1996, and Noyo River broodstock continued to constitute about 30% of the releases during the latter period. Production of coho salmon at the facility ceased entirely after 1996 (Table C.2.3.6). Adult returns averaged 245 fish between 1991 and 1996, but following the cessation of releases, no more than four coho salmon have been trapped at the hatchery in any subsequent year.

Because the Warm Spring population was originally derived from Noyo River stock and continued to receive transfers from the Noyo system throughout its operation, the BRT concluded that the hatchery population was not a part of the ESU.

Beginning in 2001, however, a captive broodstock program was initiated at the Don Clausen facility. A total of 337 juveniles were electro-fished from Green Valley and Mark West Springs creeks, two Russian River tributaries that still appear to support coho salmon, as well as

Olema Creek, a tributary to Lagunitas Creek. Specific mating protocols for these fish have not yet been determined. The captive broodstock program proposes to eventually release 50,000 fingerlings and 50,000 yearlings into five Russian River tributaries. Under the captive broodstock program, the Don Clausen Hatchery has been classified as a Category 1 hatchery (SSHAG 2003).

Kingfisher Flat (Big Creek) Hatchery—The Monterey Bay Salmon and Trout Program (MBSTP) has operated Kingfisher Flat Hatchery, located on Big Creek, a tributary to Scott Creek, since 1976. The facility is near the site of the former Big Creek Hatchery, which was operated from 1927 to 1942, when a flood destroyed the facility. An additional facility in Santa Cruz County, the Brookdale Hatchery on the San Lorenzo River, operated from 1905 to 1953. Both the Big Creek and Brookdale hatcheries were supplied with eggs taken at an egg-collection facility located on Scott Creek; additional eggs were provided from other hatcheries around the state. Production of coho salmon at both hatcheries was sporadic. Releases of Sisson (Mt. Shasta) coho salmon were made in Scott Creek and other Santa Cruz County streams in 1913, 1915, and 1917. In subsequent years, releases from both facilities back into Scott Creek in included both Scott Creek fish (1929, 1930, 1934, and 1936-1939), as well as fish from Ft. Seward, Mendocino County (1932), and Prairie Creek, Humboldt County (1933, 1935, and 1939). Throughout these years, only fry were released (generally during July through

Table C.2.3.6. Average annual releases of coho salmon juveniles (fry and smolts) from hatcheries in the CCC coho salmon ESU during release years 1987-1991, 1992-1996, and 1997-2002.

Hatchery	SSHAG Cat.	Annual Average Releases 1987-1991	1992-1996	1997-2002
Monterey Bay Salmon and Trout	1	25,764[a]	8,645[b]	3,622[b]
Silver-King		95,074[c]	0[d]	0[d]
Noyo Egg Collecting Station	1	107,918[a]	52,012[e]	72,363[e]
Don Clausen (Warm Springs) Hatchery	1	123,157[a]	56,891[f]	0[f]
Total		351,913	108,903	72,363

[a] Source: Weitkamp et al. 1995.
[b] No coho released in 1991, 1994, 1997 and 2000; all releases are smolts except for 10,095 fry released in 1996; smolts from San Lorenzo River, Noyo River, and Prairie Creek reared at Big Creek and released into San Lorenzo River are excluded from totals. Sources: MBSTP 1992-1996; Anderson 1996; Jerry Ayers, CDFG, unpublished data.
[c] Average from 4 years of data (1984-1988). Source: Weitkamp et al. 1995.
[d] Ceased operating in the 1980s.
[e] No yearling coho were released in 1995, 2000, or 2001. Sources: Grass 1992-2002.
[f] Releases included both Warm Springs Hatchery and Noyo River ECS fish.. Warm Springs Hatchery ceased releasing coho salmon in 1996. Sources: Cartwright 1994; Williams 1993; Quinones 1994-1997; CDFG Hatchery Staff 2000.

September), and numbers of fish were relatively small. In the 10 years between 1929 and 1939, during which coho salmon were planted in Scott Creek, the total fry release averaged about 34,000 fish. During the Silver-King operation, broodstock was obtained from Oregon, Washington, British Columbia, and Alaska.

Since 1976, when MBSTP began operating the Kingfisher Flat Hatchery, only local broodstock has been released back into Scott Creek; some Noyo, Prairie Creek, and San Lorenzo coho salmon were reared at the hatchery in the early 1990s, but were released into the San Lorenzo River rather than Scott Creek. Mating protocols at the hatchery follow a priority scheme in which wild x wild broodstock are used in years of relatively high abundance, wild x hatchery crosses are done when wild fish are less available, and hatchery x hatchery crosses are made when wild fish are unavailable (D. Streig, MBSTP, pers. comm.). Under the current management plan, up to 30 females and 45 males can be taken with the restriction that the first 10 spawning pairs observed must be allowed to spawn undisturbed in their natural habitat, and then only one in four females may be taken to spawn. In recent years, few or no fish have been taken, due to low abundance; however, in 2001, 123 coho were observed and 26 "wild" females were taken for spawning. Of the 123 coho observed, 40% were marked hatchery fish. There are no other data available to assess the relative contribution of hatchery versus naturally produced coho salmon.

In its 1996 coho status review update, the BRT concluded that the Kingfisher Flat (Scott Creek) hatchery population should be considered part of the ESU and was essential for ESU recovery (NMFS 1996a). This was based on the fact that there was regular incorporation of local broodstock into the hatchery population in the years that coho were produced between 1905 and 1943, and there have been no out-of-basin or out-of-ESU transfers since the hatchery was restarted in 1976. The MBSTP operation has been classified as a Category 1 hatchery (SSHAG 2003). For other SSHAG categorizations of hatchery stocks, see Appendix C.5.1.

A captive broodstock program for Scott Creek will be initiated at the NMFS Santa Cruz Laboratory in 2003.

Summary

Artificial propagation of coho salmon within the CCC ESU has been reduced since this ESU was listed in 1996 (Table C.2.3.6). The Don Clausen Hatchery has ceased production of coho salmon, and releases from the Noyo ECS operation declined over the past 6 years, in part because coho were not produced during 2 of those 6 years. The Monterey Bay Salmon and Trout Program has produced few coho salmon for release in the last 6 years due to low adult returns to Scott Creek. Genetic risks associated with out-of-basin transfers appear minimal. However, potential genetic modification in hatchery stocks resulting from domestication selection or low effective population size remains a concern.

Harvest impacts

Harvest of CCC-origin coho salmon historically occurred in coho- and chinook-directed commercial and recreational fisheries off the coast of California. Coho landing information for various ports in California are available dating back to the 1950s for commercial harvest and the early 1960s for recreational harvest; however, there are no historical estimates of either harvest or exploitation rates specific to CCC coho salmon. Likewise, there is no direct information available about the ocean distribution of coho salmon; however, it is likely that most

CCC-origin coho salmon remain in waters off of California and southern Oregon.[6] Thus, harvest management within this region is most relevant for evaluating harvest impacts.

Through the mid-1980s, the season for directed commercial harvest of coho salmon typically lasted three to almost five months throughout California. In the late 1980s and early 1990s, the commercial salmon seasons throughout California were generally shorter, particular in the region south of Pt. Delgada. By 1992, the commercial coho salmon season was closed completely from the Oregon border south to Horse Mountain, California, and open only 7 days from Pt. Arena to San Pedro. Retention of coho salmon by commercial fishers south of Cape Falcon, Oregon, including all of California, has been prohibited since 1993 (PFMC 2002b). Likewise, retention of coho salmon in recreational fisheries was prohibited in 1994 from Cape Falcon, Oregon, south to Horse Mountain, California. This prohibition was extended to include all California waters in 1996 (PFMC 2003). Non-retention regulations in both commercial and recreational fisheries remain in place throughout coastal California and southern Oregon, but selective fishing for marked hatchery coho salmon has been allowed north of Humbug Mountain, OR since 1999, and some incidental mortality of CCC coho salmon may occur in this fishery. Additionally, coho salmon are also incidentally caught or hooked in chinook fisheries off of California.

Although no estimates of incidental mortality associated with chinook fisheries are available (PFMC 2003), non-retention regulations have undoubtedly resulted in a substantial reduction in harvest-related mortality since 1993. The PFMC (2003) estimates that statewide commercial harvest of coho salmon averaged about 163,000 fish between 1952 and 1991; since 1992 there have been no known landings of coho salmon. Ocean recreational harvest of coho salmon averaged about 34,000 fish from 1962 to 1993. Total estimated incidental and illegal harvest of coho salmon has not exceeded 1000 fish in any year since non-retention regulations were put in place.

There is no legal inside harvest of coho salmon within the CCC ESU; any fishery mortality results from incidental catch-and-release hooking mortality in other fisheries. There are no estimates of inside harvest or mortality of coho salmon in the CCC ESU (PFMC 2003); however, CDFG (2003) considers the potential for significant incidental mortality (and poaching) to be low because of the minimal overlap between the coho migration season and the steelhead season (CDFG 2003).

C.2.3.5 Comparison with Previous Data

New data for the CCC coho salmon ESU includes expansion of presence-absence analyses, an analysis of juvenile abundance in 13 river basins, smolt counts from two streams in the central portion of the ESU, and one adult time series for a population with mixed wild and hatchery fish. The presence-absence analysis suggests possible continued decline of coho salmon between the late 1980s and the late 1990s, a pattern that is mirrored in the limited smolt and adult counts. Juvenile time series suggest no obvious recent change in status, but most

[6] Rogue/Klamath hatchery stocks, which serve as fishery surrogate stocks for SONCC coho salmon are generally distributed south of Humbug Mountain, Oregon. It is likely that CCC coho salmon exhibit a more southerly ocean distribution.

observations underlying that analysis were made in the period from 1993 to 2002. Coho salmon populations continue to be depressed relative to historical numbers, and there are strong indications that breeding groups have been lost from a significant percentage of streams within their historical range. A number of coho populations in the southern portion of the range appear either extinct or nearly so, including those in the Gualala, Garcia, and Russian Rivers, as well as smaller coastal streams in San Francisco Bay and South of San Francisco Bay. Although the 2001 broodyear appears to relatively strong, data were not yet available from many of the most at-risk populations within the CCC.

No new information has been provided that suggests additional risks beyond those identified in previous status reviews. Termination of hatchery production at the Don Clausen (Warm Springs) Hatchery and reductions in production at the Noyo and Kingfisher Flat (Big Creek) facilities suggest a decrease in potential risks associated with hatcheries; however, the lack of substantive information regarding the relative contribution of hatchery and naturally produced fish at these facilities adds uncertainty as to the potential risks these operations may pose to the genetic integrity of the Noyo River and Scott Creek stocks. Restrictions on recreational and commercial harvest of coho salmon since 1993-1994 have substantially reduced exploitation rate on CCC coho salmon.

C.2.4 LOWER COLUMBIA RIVER COHO SALMON

Primary contributor: Paul McElhany
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C.2.4.1 Summary of Previous BRT Conclusions

The status of Lower Columbia River coho salmon was initially reviewed by the National Marine Fisheries Service (NMFS) in 1996 (NMFS 1996b) and the most recent review occur in 2001 (NMFS 2001a). In the 2001 review, the Biological Review Team (BRT) was very concerned that the vast majority (over 90%) of the historical populations in the Lower Columbia River coho salmon ESU appear to be either extirpated or nearly so. The two populations with any significant production (Sandy and Clackamas) were at appreciable risk because of low abundance, declining trends and failure to respond after a dramatic reduction in harvest. The large number of hatchery coho salmon in the ESU was also considered an important risk factor. The majority of the 2001 BRT votes were for “at risk of extinction” with a substantial minority in “likely to become endangered.”

Current Listing Status—candidate species

C.2.4.2 New Data and Updated Analyses

New data include spawner abundance estimates through 2002 for Clackamas and Sandy populations (the previous status review had data just through 1999). In addition, the Oregon Department of Fish and Wildlife (ODFW) conducted surveys of Oregon Lower Columbia River coho salmon using a stratified random sampling design in 2002, which provided the first abundance estimates for lower tributary populations (previously only limited index surveys were available. Estimates of the fraction of hatchery-origin spawners accompany the new abundance estimates. In Washington, no surveys of natural-origin adult coho salmon abundance are conducted. Updated information through 2002 on natural-origin smolt production from Cedar, Mill, Germany, and Abernathy creeks and the upper Cowlitz River were provided by the Washington Department of Fish and Wildlife (WDFW).

New analyses include the tentative designation of demographically independent populations, the recalculation of metrics reviewed by previous BRTs with additional years of data, estimates of median annual growth rate (λ) under different assumptions about the reproductive success of hatchery fish, a new stock assessment of Clackamas River coho by ODFW (Zhou and Chilcote 2003), and estimates of current and historically available kilometers of stream.

Historical population structure—As part of its effort to develop viability criteria for Lower Columbia River salmon and steelhead, the Willamette/Lower Columbia Technical Recovery Team (WLC-TRT) has identified historically demographically independent populations of Endangered Species Act-listed salmon and steelhead in the Lower Columbia River (Myers et al. 2002). Population boundaries are based on an application of Viable Salmonid Populations definition (McElhany et al. 2000). Based on the WLC-TRT’s framework for chinook and steelhead, the BRT tentatively designated populations of Lower Columbia River coho salmon (Figure C.2.4.1). A working group at the Northwest Fisheries Science Center hypothesized that the Lower Columbia River coho salmon ESU historically consisted of 23 populations. These population designations have not yet been reviewed by the WLC-TRT. With the exception of the Clackamas coho, the populations shown in Figure C.2.4.1 are used as the units for the new analyses in this report.

Previous BRT and ODFW analyses have treated the coho in the Clackamas River as a single population (see previous status review updates for more complete discussion and references). However, recent analysis by ODFW (Zhou and Chilcote 2003) supports the hypothesis that coho salmon in the Clackamas River consist of two populations, an early run and a late run. The late run population is believed to be descendant of the native Clackamas River population, and the early run is believed to descend from hatchery fish introduced from Columbia River populations outside the Clackamas River basin. There is uncertainty about the population structure of Clackamas River coho; therefore, in this report, analyses on Clackamas River coho are conducted under both the single population and two population hypotheses for comparison.

For other salmonid species, the WLC-TRT partitioned Lower Columbia River populations into a number of “strata” based on major life-history characteristics and ecological zones (McElhany et al. 2003). These analyses suggest that a viable ESU would require a number of viable populations in each of these strata. Coho salmon do not have the major life-history variation seen in Lower Columbia River steelhead or chinook, and would thus be divided into strata based only on ecological zones. The strata and associated populations for coho salmon are identified in Table C.2.4.1.

Abundance and trends

Recent abundance of natural-origin spawners, and recent fraction of hatchery-origin spawners for Lower Columbia River coho salmon populations are summarized in Table C.2.4.1. Natural-origin fish are defined as those whose parents that spawned in the wild, while hatchery-origin fish are defined as those whose parents were spawned in a hatchery. Some populations (e.g. North Fork Lewis River) are above impassible barriers and are completely extirpated. Most of the other populations, except for the Clackamas and Sandy Rivers are believed to have very little, if any, natural production. References for abundance time series and related data are in Appendix C.5.2.

Clackamas—The Clackamas River population above the North Fork Dam is one of only two populations in the ESU for which natural production trends can be estimated. The portion of the population above the dam has a relatively low fraction of hatchery-origin spawners, while the area below the dam is dominated by hatchery-origin spawners (Table C.2.4.1). The recent average number of coho salmon above the dam is shown in Table C.2.4.2, and counts of total adults and natural-origin adults passing the North Fork dam is shown in Figure C.2.4.2. Prior to 1973, hatchery-origin adults and juveniles were released above North Fork Dam, and the time series from 1957-1972 contains an unknown fraction of hatchery-origin spawners. Since almost all Lower Columbia River coho salmon females and most males spawn at 3 years of age, a strong cohort structure is produced. Figure C.2.4.3 shows the three adult cohorts on the Clackamas. As discussed in the section on population structure, multiple hypotheses exist regarding the number of historical and current populations in the Clackamas basin. Zhou and Chilcote (2003) partitioned current Clackamas River coho above North Fork into two populations (Figure C.2.4.4). Figure C.2.4.5 shows the number of juvenile coho outmigrants passing the North Fork Dam from 1957-2002.

Table C.2.4.1. Recent abundance of natural-origin spawners and recent fraction of hatchery-origin spawners for Lower Columbia River coho salmon populations. The ecological zones are based on ecological community and hydrodynamic patterns. Abundance and hatchery fraction are based on ODFW and Portland General Electric (PGE) data. ND - no data available.

<table>
<tr><th>Ecological Zone</th><th>Putative Population</th><th>2002 Total Spawners</th><th>2002 Hatchery Fraction (%)</th><th>2002 Natural-origin Smolts</th></tr>
<tr><td rowspan="7">Coastal</td><td>Youngs Bay</td><td rowspan="2">4,473 (combined Youngs bay and Big Creek)</td><td rowspan="2">91</td><td>ND</td></tr>
<tr><td>Big Creek</td><td>ND</td></tr>
<tr><td>Grays River</td><td>ND</td><td>ND</td><td>ND</td></tr>
<tr><td>Elochoman</td><td>ND</td><td>ND</td><td>ND</td></tr>
<tr><td>Clatskanie</td><td>229</td><td>60</td><td>ND</td></tr>
<tr><td>Mill, Germany, Abernathy</td><td>ND</td><td>ND</td><td>22,700</td></tr>
<tr><td>Scappoose</td><td>458</td><td>0</td><td>ND</td></tr>
<tr><td rowspan="14">Cascade</td><td>Cispus</td><td>ND</td><td>ND</td><td rowspan="3">168,281</td></tr>
<tr><td>Tilton</td><td>ND</td><td>ND</td></tr>
<tr><td>Upper Cowlitz</td><td>ND</td><td>ND</td></tr>
<tr><td>Lower Cowlitz</td><td>ND</td><td>ND</td><td>ND</td></tr>
<tr><td>North Fork Toutle</td><td>ND</td><td>ND</td><td>ND</td></tr>
<tr><td>South Fork Toutle</td><td>ND</td><td>ND</td><td>ND</td></tr>
<tr><td>Coweeman</td><td>ND</td><td>ND</td><td>ND</td></tr>
<tr><td>Kalama</td><td>ND</td><td>ND</td><td>ND</td></tr>
<tr><td>North Fork Lewis</td><td>ND</td><td>ND</td><td>32,695 (Cedar Creek only)</td></tr>
<tr><td>East Fork Lewis</td><td>ND</td><td>ND</td><td>ND</td></tr>
<tr><td>Clackamas</td><td>1,001 (above North Fork)
2,402 (below North Fork)</td><td>12 (above N. Fork)
78 (below N. Fork)</td><td>ND</td></tr>
<tr><td>Salmon Creek</td><td>ND</td><td></td><td>ND</td></tr>
<tr><td>Sandy</td><td>310 (above Marmont)
271 (below Marmot)</td><td>0 (above Marmot)
97 (below Marmot)</td><td>ND</td></tr>
<tr><td>Washougal</td><td>ND</td><td>ND</td><td>ND</td></tr>
<tr><td rowspan="4">Gorge</td><td>Lower Gorge Tributaries</td><td>ND</td><td>ND</td><td>ND</td></tr>
<tr><td>White Salmon</td><td>ND</td><td>ND</td><td>ND</td></tr>
<tr><td>Upper Gorge Tributaries</td><td rowspan="2">1,317 (Combined Hood River and Oregon only upper gorge)</td><td rowspan="2">>65*</td><td>ND</td></tr>
<tr><td>Hood River</td><td>ND</td></tr>
</table>

*Contain an unknown (i.e. unmarked) additional fraction of hatchery-origin coho from upstream releases.

Table C.2.4.2. Recent abundance estimates for subset of Lower Columbia coho populations.

Population		Years for Recent Means	Recent Geometric Mean	Recent Arithmetic Mean
Clackamas (above North Fork Dam)	Total	2000 – 2002	2,122	2,453
	Early Run	1996-1999	302	531
	Late Run	1996-1999	35	100
Sandy (above Marmot Dam)		2000 – 2002	643	739

The long-term trends and growth rate (λ) estimates over the entire time series for the total count at North Fork Dam and the early run portion have been slightly positive and the short-term trends and λ have been slightly negative (Tables C.2.4.3 and C.2.4.4).

Table C.2.4.3. Long-term trend and growth rate for subset of Lower Columbia coho salmon populations (95% C.I. are in parentheses). The long-term analysis used the entire data set (see Table C.2.4.2 for years). The λ calculation estimates the natural growth rate after accounting for hatchery-origin spawners. Since the fraction of hatchery-origin spawners prior to 1973 in the Clackamas River is unknown, λ estimates for the Clackamas River use data from 1973 onward. The λ estimate is calculated under two hypotheses about the reproductive success of hatchery-origin spawners: Hatchery = 0 - hatchery fish are assumed to have zero reproductive success; Hatchery = Wild - hatchery fish are assumed to have the same reproductive success as natural-origin fish.

Population		Years for Trend	Trend of Total Spawners	Years for λ	Median Growth Rate (λ)	
					Hatchery = 0	Hatchery = Wild
Clackamas (above North Fork Dam)	Total	1957 – 2002	1.009 (0.994 – 1.024)	1973 – 2002	1.028 (0.898 – 1.177)	1.026 (0.897 – 1.174)
	Early Run	1973 – 1998	1.080 (1.015 – 1.149)	1973 – 1998	1.085 (0.944 – 1.248)	1.085 (0.944 – 1.248)
	Late Run	1973 – 1998	0.926 (0.863 – 0.993)	1973 – 1998	0.958 (0.834 – 1.102)	0.958 (0.834 – 1.102)
Sandy		1977 – 2002	0.997 (0.941 – 1.056)	1977 – 2002	1.012 (0.874 – 1.172)	1.012 (0.874 – 1.172)

Table C.2.4.4. Short-term trend and growth rate for subset of Lower Columbia coho populations (95% C.I. are in parentheses). Short-term data sets include data from 1990 to the most recent available year. The λ calculation estimates the natural growth rate after accounting for hatchery-origin spawners. The λ estimate is calculated under two hypotheses about the reproductive success of hatchery-origin spawners: Hatchery = 0 - hatchery fish are assumed to have zero reproductive success; Hatchery = Wild - hatchery fish are assumed to have the same reproductive success as natural-origin fish.

Population		Years for Trend	Trend of Total Spawners	Years for λ	Median Growth Rate (λ)	
					Hatchery = 0	Hatchery = Wild
Clackamas (above North Fork Dam)	Total	1990 – 2002	0.949 (0.832 – 1.083)	1990 – 2002	0.975 (0.852 – 1.116)	0.970 (0.848 – 1.110)
	Early Run	1990 – 1998	0.884 (0.601 – 1.302)	1990 – 1998	0.902 (0.785 – 1.037)	0.902 (0.785 – 1.037)

	Late Run	1990 – 1998	0.734 (0.406 – 1.325)	1990 – 1998	0.843 (0.734 – 0.969)	0.843 (0.734 – 0.969)
Sandy		1990 – 2002	0.964 (0.841 – 1.105)	1977 – 2002	0.979 (0.845 – 1.133)	0.978 (0.845 – 1.132)

The late run portion of the North Fork Dam count (hypothesized to be the remains of the historical Clackamas River coho population) shows negative trends and growth rates over both the long and short term. However, the confidence intervals on trend and growth rate are large, so there is a great deal of uncertainty. Both the long-term and short-term trends and λ have relatively high probabilities of being less than one (Tables C.2.4.5 and C.2.4.6).

Table C.2.4.5. Probability that the long-term abundance trend or growth rate of Lower Columbia River coho salmon is less than one: Hatchery = 0 - hatchery fish are assumed to have zero reproductive success; Hatchery = Wild - hatchery fish are assumed to have the same reproductive success as natural-origin fish.

Population		**Years for Trend**	**Prob. Trend <1**	**Years for λ**	**Prob. λ < 1**	
					Hatchery = 0	**Hatchery = Wild**
Clackamas (above North Fork Dam)	Total	1957 – 2002	0.123	1973 – 2002	0.283	0.296
	Early Run	1993 – 1998	0.008	1973 – 1998	0.148	0.148
	Late Run	1973 – 1998	0.984	1973 – 1998	0.724	0.724
Sandy		1977 – 2002	0.544	1977 – 2002	0.426	0.427

Table C.2.4.6. Probability that the short-term abundance trend or growth rate of Lower Columbia River coho salmon is less than one: Hatchery = 0 - hatchery fish are assumed to have zero reproductive success; Hatchery = Wild - hatchery fish are assumed to have the same reproductive success as natural-origin fish.

Population		**Years for Trend**	**Prob. Trend <1**	**Years for λ**	**Prob. λ < 1**	
					Hatchery = 0	**Hatchery = Wild**
Clackamas (above North Fork Dam)	Total	1990 – 2002	0.799	1990 – 2002	0.582	0.600
	Early Run	1990 – 1998	0.762	1990 – 1998	0.711	0.711
	Late Run	1990 – 1998	0.872	1990 – 1998	0.836	0.836
Sandy		1990 – 2002	0.716	1990 – 2002	0.564	0.566

Since the late 1980s, the number of pre-harvest recruits has declined relative to the number of spawners (Figures C.2.4.6 and C.2.4.7). Despite upturns in the last 2 years, the population has had more years below replacement since 1990 than above. Thus, even with the dramatic reductions in harvest rate (Figure C.2.4.8), the population failed to respond during the

1990s because of this recruitment failure. Although the recent increases in recruitment are encouraging, the population has not regained earlier levels and is unknown if they will persist. The recent increases in recruitment are attributable in some part to increased marine survival and marine survival cannot predict with any certainty.

Based on stock assessment analysis under the assumption that the ClackamasRiver coho consist of two populations, Zhou and Chilcote (2003) concluded that the early (introduced) run had a relatively low risk of extinction, whereas the late (native) run had a relatively high risk of extinction.

Sandy—The Sandy River population above Marmot Dam and the Clackamas River population(s) above North Fork Dam are the only populations in the ESU for which natural production trends can be estimated. The portion of the Sandy River population above Marmot Dam has almost no hatchery-origin spawners, while the area below the dam is dominated by hatchery-origin spawners (Table C.2.4.1). The recent average number of coho salmon above Marmot Dam is shown in Table C.2.4.2. Figure C.2.4.8 shows the total adult count passing the dam, while Figure C.2.4.9 shows the three adult cohorts on the Sandy River.

The long-term and short-term trends for the counts at Marmot Dams are both slightly negative (Tables C.2.4.3 and C.2.4.4). The long-term λ is slightly positive and the short-term λ is slightly negative (Tables C.2.4.3 and C.2.4.4). However, the confidence intervals on trend and growth rate are large, so there is a great deal of uncertainty. Both the long-term and short-term trends and λ have relatively high probabilities of being less than one (Tables C.2.4.5 and C.2.4.6).

The late 1980s recruitment failure observed in the Clackamas is also present in the Sandy River population (Figures C.2.4.10 and C.2.4.11). If anything, it may be more pronounced in the Sandy River system, and overall coho salmon abundance levels are lower. Again, despite reductions in harvest (Figure C.2.4.12), the Sandy River coho population has failed to recover to earlier recruitment levels, despite the encouraging returns in 2000 and 2001. The 2002 return showed a decline from 2000 and 2001 abundance levels (Figure C.2.4.8).

Other Oregon populations

ODFW initiated a large effort in 2002 to obtain abundance estimates of Lower Columbia coho salmon using a random stratified sampling protocol similar to that used to estimate abundance of Oregon coastal coho salmon. Results from this survey are presented in Table C.2.4.1. These surveys indicate that Oregon Lower Columbia River coho salmon are dominated by hatchery-origin spawners, but there are some potential pockets of natural production (e.g. Scappoose Creek). With only data for one year, it is difficult reach conclusions about the abundance of coho salmon in Oregon populations down stream of the Willamette River. Marine survival for Lower Columbia River coho salmon returning in 2002 was relatively high and the Lower Columbia River tributary counts in 2002 are likely to be higher than in low marine survival years.

Prior to 2002, ODFW conducted coho salmon spawner surveys in lower Colombia River We combined these surveys to obtain spawners-per-mile information at the scale of our population units (Figures C.2.4.13- C.2.4.16). In many years over the last two decades, these surveys have observed no natural-origin coho salmon spawners. Based on the spawners-per-mile survey data, previous assessments have concluded that coho salmon in these populations are extinct or nearly so (ODFW 1995a, NMFS 2001b).

Washington populations

The Washington side of this ESU is also dominated by hatchery production, and there are no populations known to be naturally self-sustaining. A study by NRC (1996) indicated that 97% of 425 fish surveyed on the spawning grounds were first-generation hatchery fish. There are no estimates of spawner abundance for Washington Lower Columbia River coho salmon populations. However, WDFW has recently conducted some trapping of juvenile outmigrant coho (Table C.2.4.7). These data indicate that some natural production is occurring in the Lewis River and Mill-Germany-Abernathy Creeks populations, but there is no direct way to determine if these populations would be naturally self-sustaining in the absence of hatchery-origin spawners. WDFW suggests that juvenile outmigrant production seen in the monitored streams is typical of other Washington Lower Columbia River streams and that a fairly substantial number of natural-origin spawners may return to the Lower Columbia River each year. Preliminary calculations by WDFW suggest that the natural pre-harvest recruitment from the monitored streams alone may be 17,000 adults (assuming 4% marine survival) (Haymes 2003).

The area above Cowlitz Falls is also capable of natural outmigrant production (Table C.2.4.7). However, these populations are not considered currently self-sustaining (Rawding, pers. comm.). The upper Cowlitz River is blocked to anadromous passage by three dams. Currently, adult coho salmon (some of hatchery origin) are collected below the lower dam (Mayfield Dam) and trucked to the area above the upper dam (Cowlitz Falls Dam). There is no appreciable downstream passage through the dams, so juvenile outmigrants are collected at Cowlitz Falls Dam and trucked below Mayfield Dam. At this time, collection efficiency of outmigrating juveniles at Cowlitz Falls is so low (40-60%) that the spawners could not replace themselves (i.e. fewer adult coho salmon return from the relatively low number of outmigrants that are released below Mayfield Dam than are planted above Cowlitz Falls Dam). Thus, the populations are maintained by hatchery production (in addition to the trap and haul operation).

Table C.2.4.7: Estimates of natural coho salmon juvenile outmigrants from Washington Lower Columbia River streams. Estimates are based on expansions from smolt traps, not total census. Cedar Creek is a tributary of the North Fork Lewis River population. Mill, Germany and Abernathy Creeks are combined into a single population unit for BRT analysis. The Cowlitz River above Cowlitz Falls is partitioned into three independent populations (Upper Cowlitz, Cispus, and Tilton Rivers). The East Fork Lewis River estimate shows a range based on uncertainties about trap efficiency.

Out-migrant Year	Cedar Creek	Mill Creek	Abernathy Creek	Germany Creek	East Fork Lewis River	Cowlitz River above Cowlitz Falls
1997						17,490

1998	38,354					196,520
1999	27,987					88,788
2000	20,282				4,514-9,028	236,960
2001	20,695	6,324	6,991	8,157		796,948
2002	32,695	9,500	6,200	7,000		168,281

C.2.4.3 New Hatchery Information

Hatchery production

The Lower Columbia River coho salmon ESU is dominated by hatchery production. Recent coho salmon releases in the Columbia River basin (including releases upstream of the ESU boundary) are shown in Table C.2.4.8. The total expected return of hatchery coho salmon to the Columbia basin in 2002 was over a million adults (ODFW News Release, 13 September, 2002; at the time of this report, final 2002 return data are not available).

Table C.2.4.8. Total coho salmon hatchery releases into the Columbia River basin (from DART website http://www.cqs.washington.edu/dart/hatch.html made available by the Fish Passage Center).

Year	Hatchery Releases
2000	29,902,509
2001	25,730,650
2002	20,011,742

Loss of habitat from barriers

Steel and Sheer (2002) analyzed the number of stream km historically and currently available to salmon populations in the Lower Columbia River (Table C.2.4.9). Stream kilometers usable by salmon are determined based on simple gradient cut-offs and on the presence of impassable barriers. This approach overestimates the number of usable stream kilometers, as it does not take into consideration aspects of habitat quality other than gradient. However, the analysis does indicate that the number of kilometers of stream habitat currently accessible is greatly reduced from the historical condition for some populations.

Table C.2.4.9. Loss of habitat from barriers. The potential current habitat is the kilometers of stream below all currently impassible barriers between a gradient of 0.5% and 4%. The potential historical habitat is the kilometers of stream below historically impassible barriers between a gradient of 0.5% and 4%. The current-to-historical habitat ratio is the percent of the historical habitat that is currently available. This table does not consider habitat quality. The Upper Cowlitz, Cispus and Tilton habitats are listed in this analysis as currently inaccessible because volitional passage is not possible. However, a trap-and-haul reintroduction program for these populations has been initiated.

Population	Potential Current Habitat (%)	Potential Historical Habitat (km)	Current/ Historical Habitat Ratio

Youngs Bay	178	195	91
Grays River	133	133	100
Big Creek	92	129	71
Elochoman River	85	116	74
Clatskanie River	159	159	100
Mill, Germany, Abernathy Creeks	117	123	96
Scappoose Creek	122	157	78
Cispus River	0	76	0
Tilton River	0	93	0
Upper Cowlitz River	4	276	1
Lower Cowlitz River	418	919	45
North Fork Toutle River	209	330	63
South Fork Toutle River	82	92	89
Coweeman River	61	71	86
Kalama River	78	83	94
North Fork Lewis River	115	525	22
East Fork Lewis River	239	315	76
Clackamas River	568	613	93
Salmon Creek	222	252	88
Sandy River	227	286	79
Washougal River	84	164	51
Lower Gorge Tributaries	34	35	99
Upper Gorge Tributaries	23	27	84
White Salmon River	0	71	0
Hood River	35	35	100
Total	3,286	5,272	62

ESU summary

Based on the updated information provided in this report, the information contained in previous Lower Columbia River status reviews, and preliminary analyses by the WLC-TRT, we have tentatively identified the number of historical and currently viable populations. Only two putative populations have demonstrated appreciable levels of natural production (Clackamas River, Sandy River). There is only very limited information on the remainder of the 21 putative populations, but most were considered extirpated, or nearly so, during the low marine survival period of the 1990s (reviewed in NMFS 2001a). Recently initiated spawner surveys by ODFW and juvenile outmigrant trapping by WDFW indicate there is some natural production in the Lower Columbia River. However, the majority of populations remain dominated by hatchery-origin spawners, and there is little data to indicate they would naturally persist in the long term. Of the two populations where natural production can be evaluated, both have experienced recruitment failure over the last decade. Recent abundances of the two populations are relatively low (especially the Sandy River), placing them in a range where environmental, demographic and genetic stochacity can be significant risk factors.

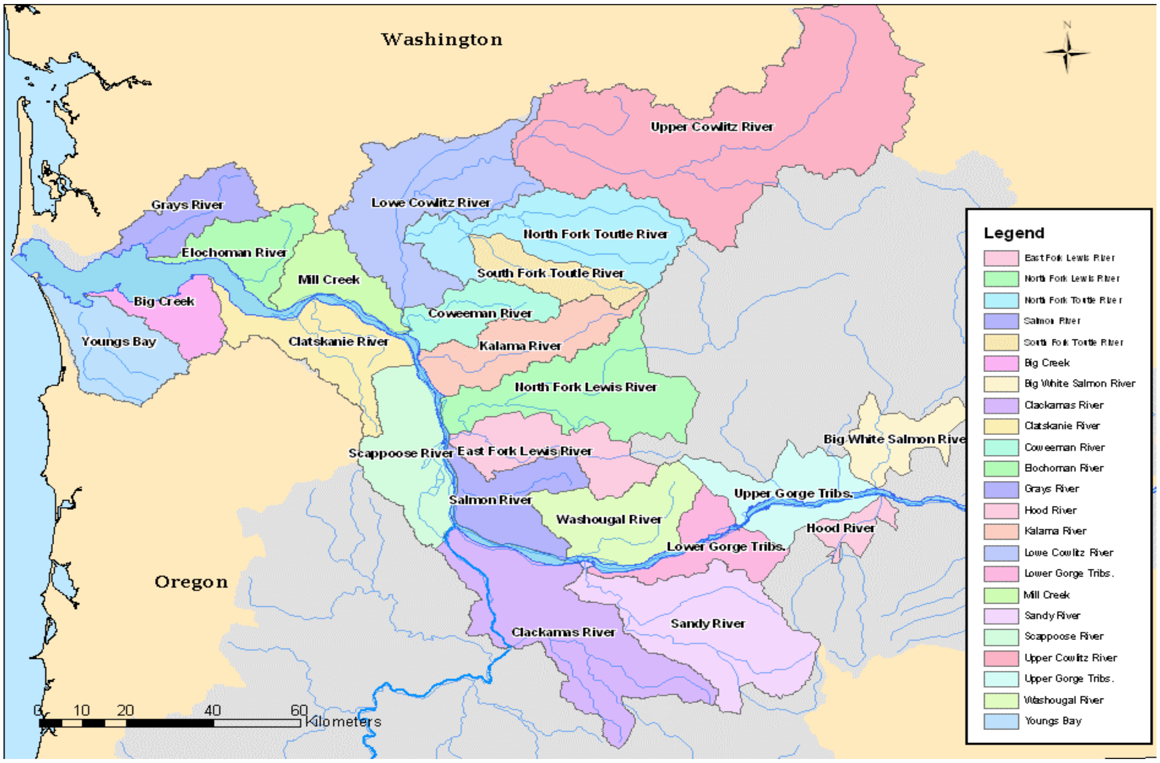

Figure C.2.4.1. Tentative historical populations of Lower Columbia River coho salmon. Based on work by WLC-TRT for chinook and steelhead (Myers et al. 2002).

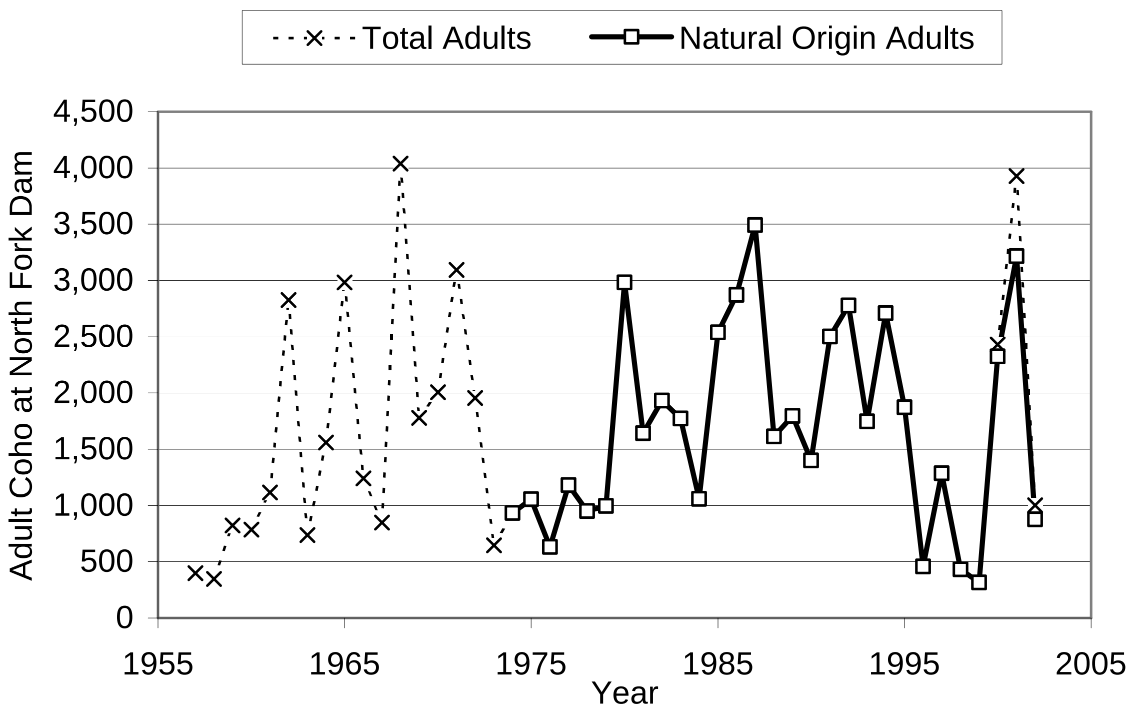

Figure C.2.4.2. Clackamas North Fork Dam counts of adult (three-year-old) coho salmon.

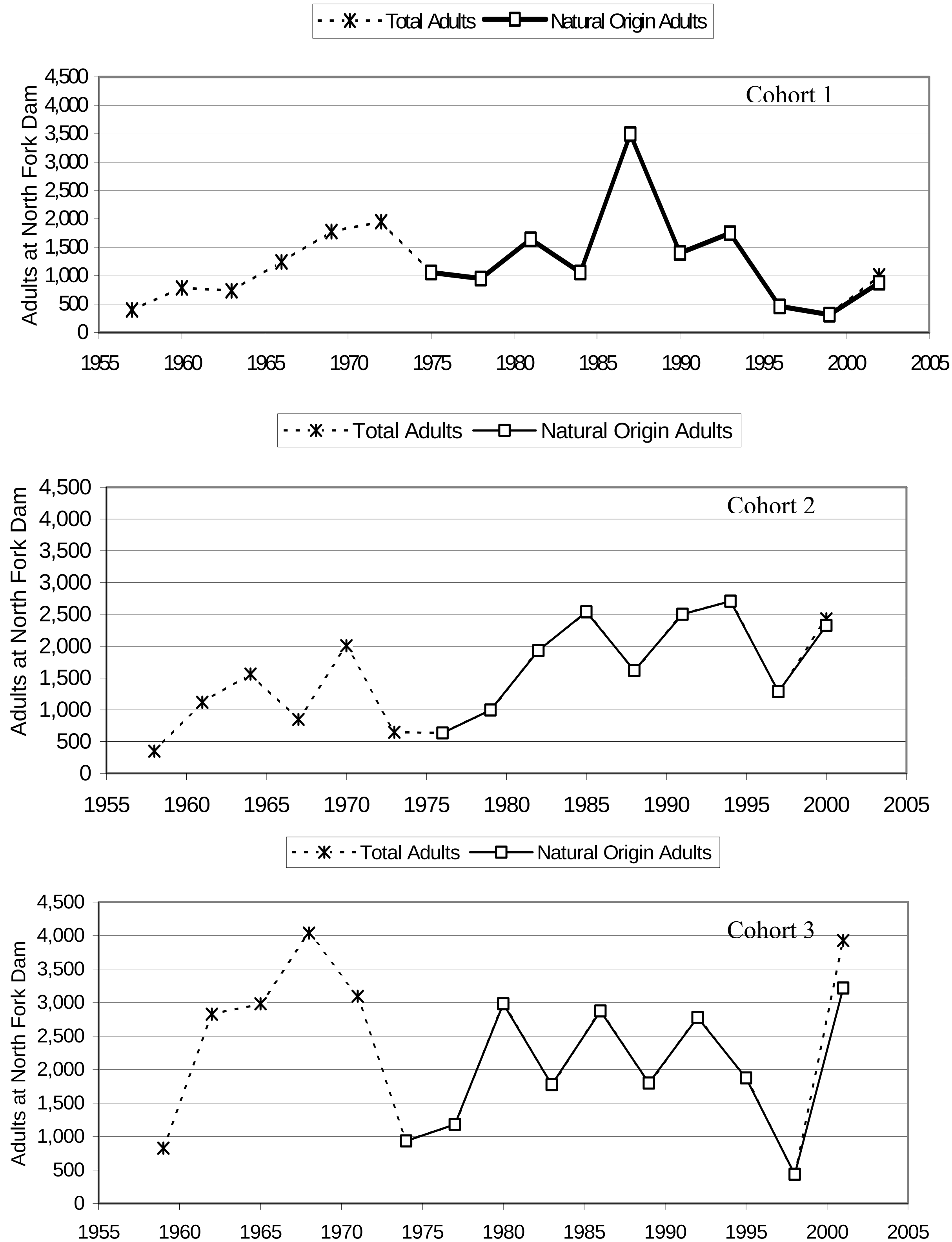

Figure C.2.4.3. Clackamas North Fork Dam counts of adult (three-year-old) coho salmon by cohort.

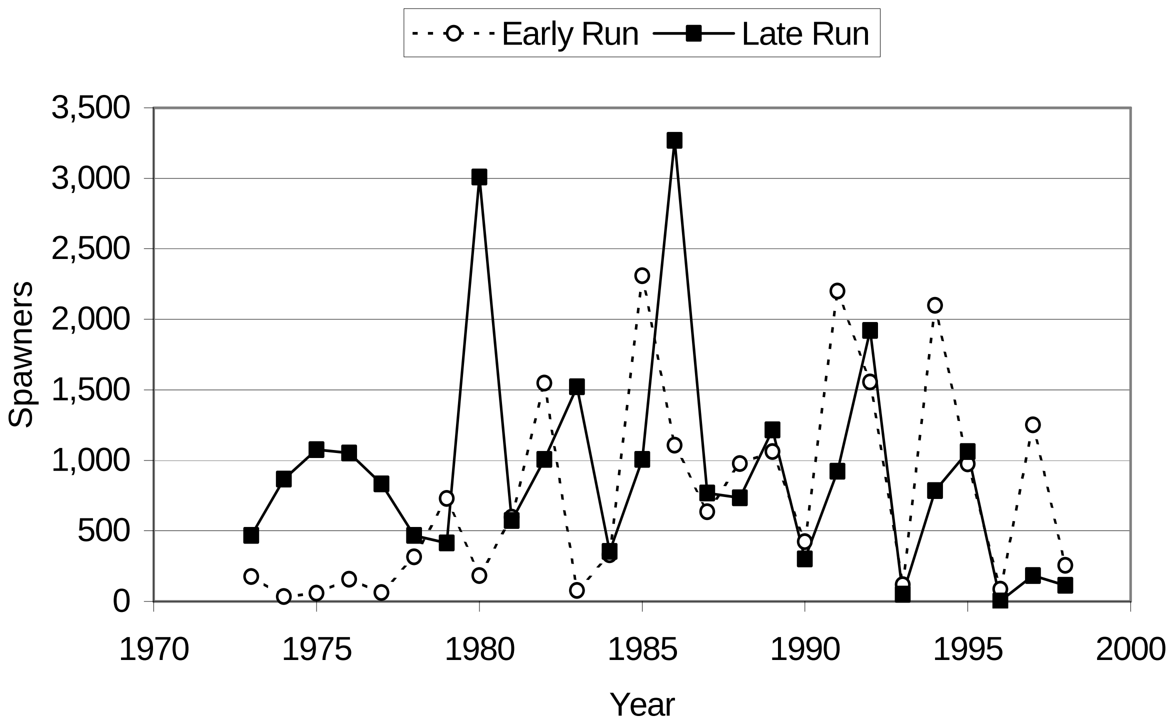

Figure C.2.4.4. Clackamas River early-run and late-run coho salmon. Run designation is based on a maximum likelihood approach assuming two populations with different mean run times (Zhou and Chilcote 2003).

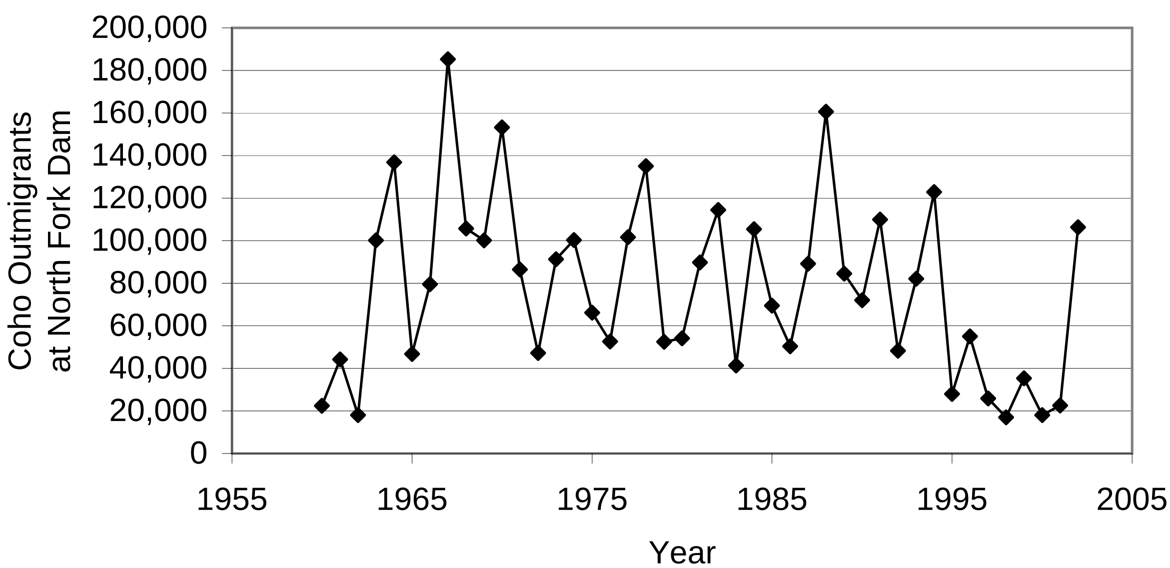

Figure C.2.4.5. Total outmigrating juvenile coho passing Clackamas North Fork Dam (Doug Cramer, pers. comm., June 5, 2003).

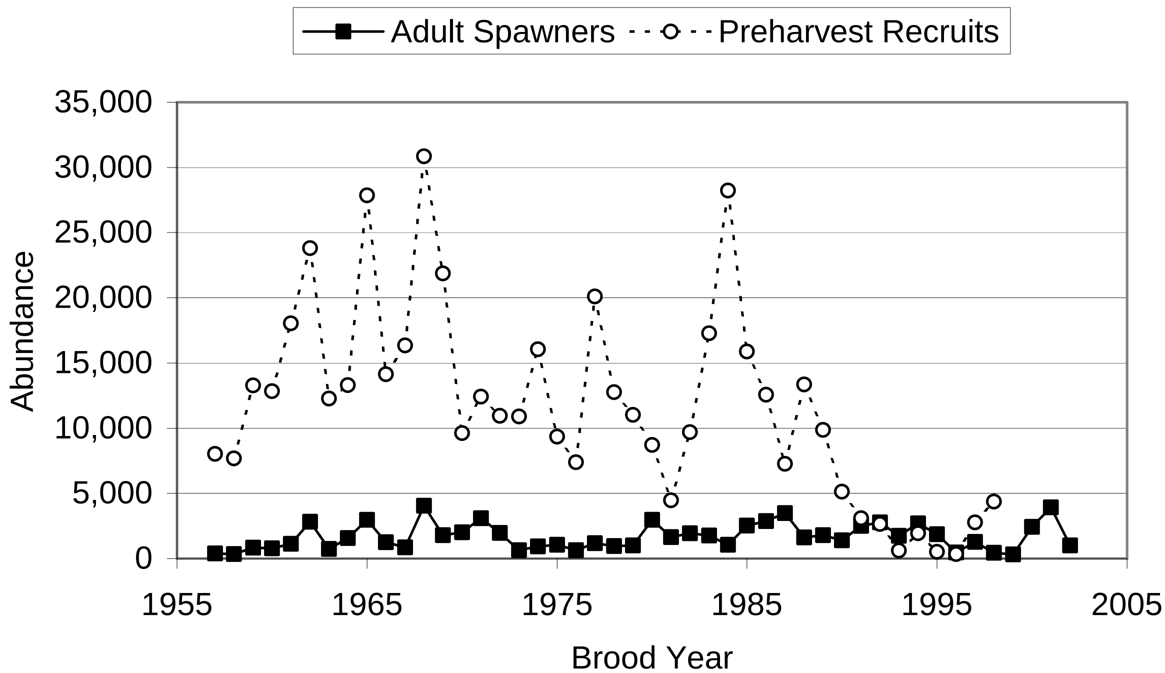

Figure C.2.4.5. Estimate of pre-harvest coho salmon recruits and spawners in the Clackamas River. Based on adult counts at North Fork Dam.

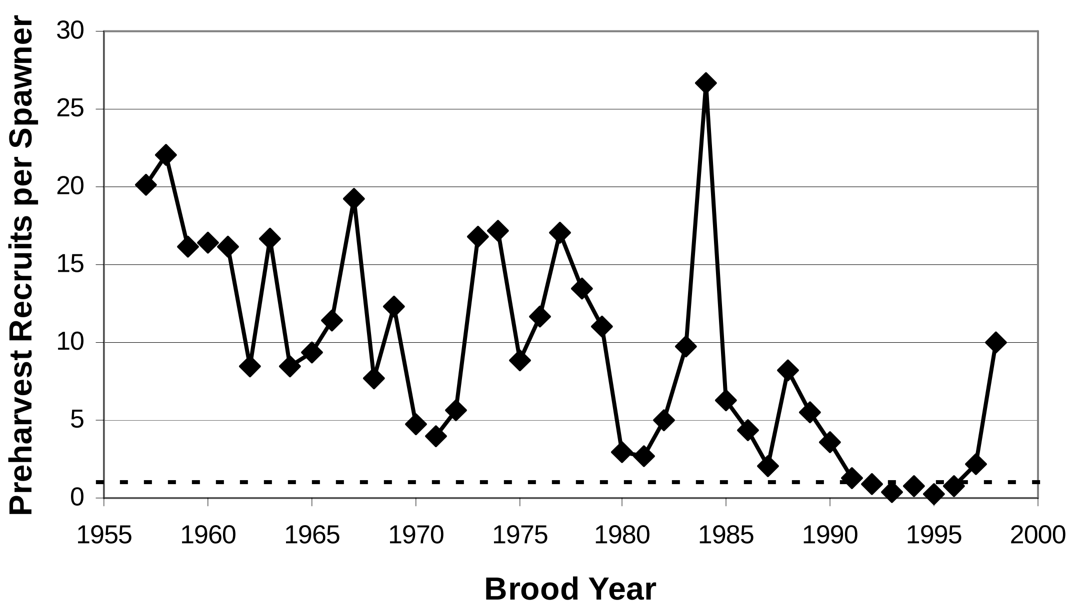

Figure C.2.4.6. Estimate of pre-harvest coho salmon recruits-per-spawner in the Clackamas River. Based on adult counts at North Fork Dam. The dashed line indicates the replacement level.

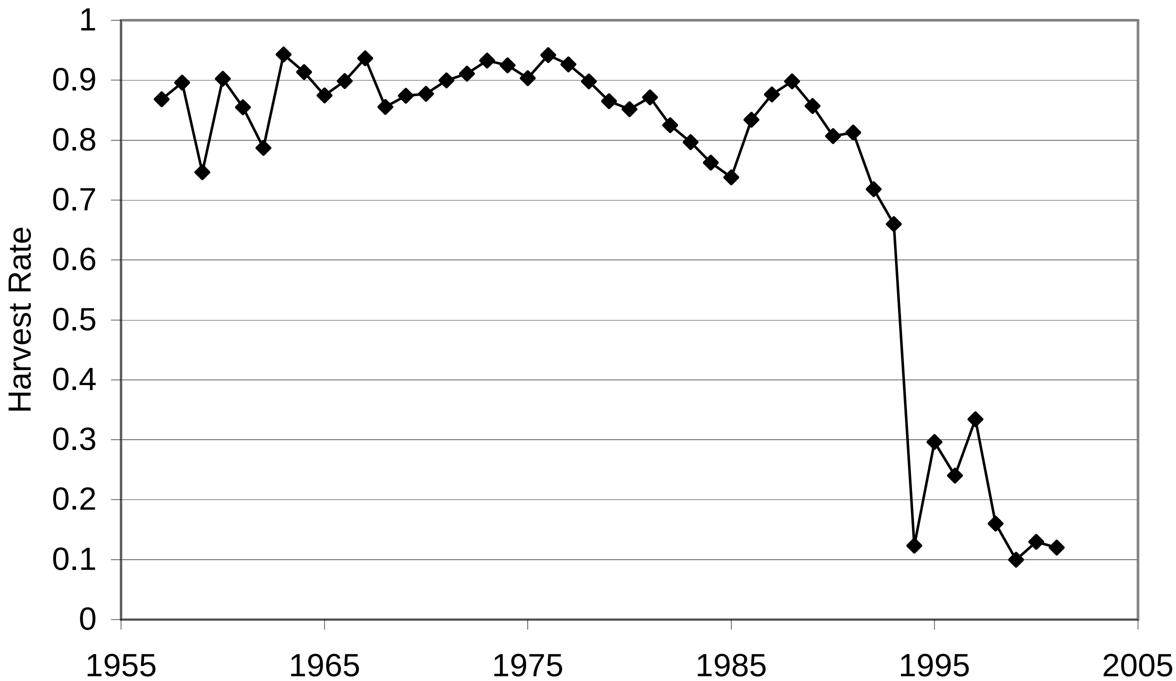

Figure C.2.4.7. Clackamas River natural-origin coho salmon harvest rate (M. Chilcote, pers. comm.). The reduction in harvest rate was achieved by a switch to retention-only marked hatchery fish and timing the fishery to protect natural runs.

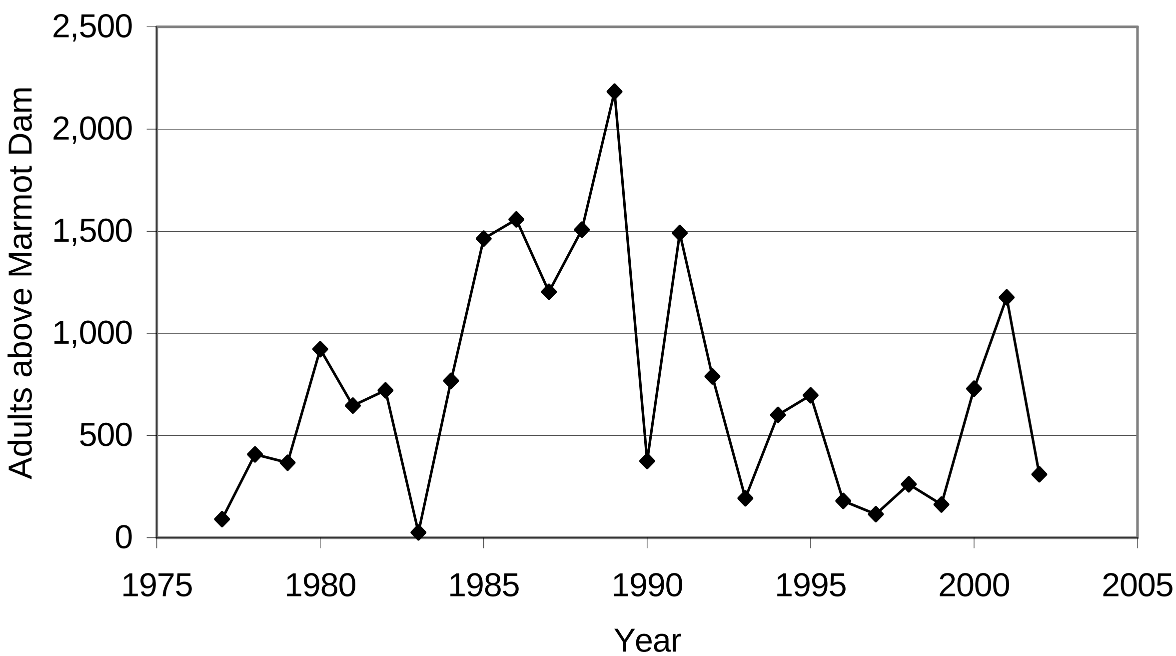

Figure C.2.4.8. Count of adult (≥3 years old) coho salmon at the Marmot Dam on the Sandy River. Almost all spawners above Marmot Dam are natural origin. For no year is the proportion of hatchery-origin spawners estimated to be greater than 2.5%.

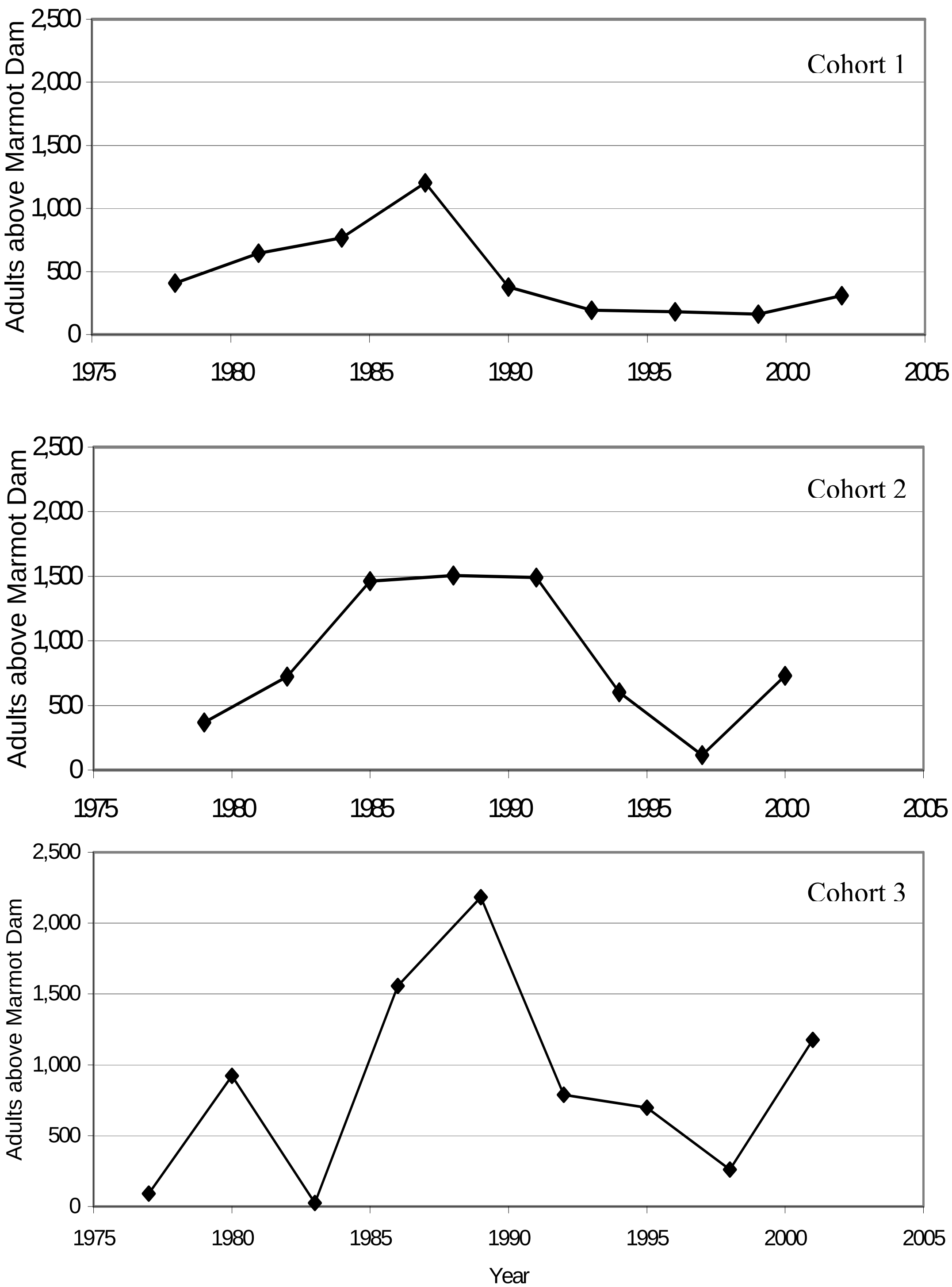

Figure C.2.4.9. Count of adult (≥3 years old) coho salmon at the Marmot Dam on the Sandy River by cohort. Almost all spawners above Marmot Dam are natural origin. For no year is the proportion of hatchery-origin spawners estimated to be greater than 2.5%.

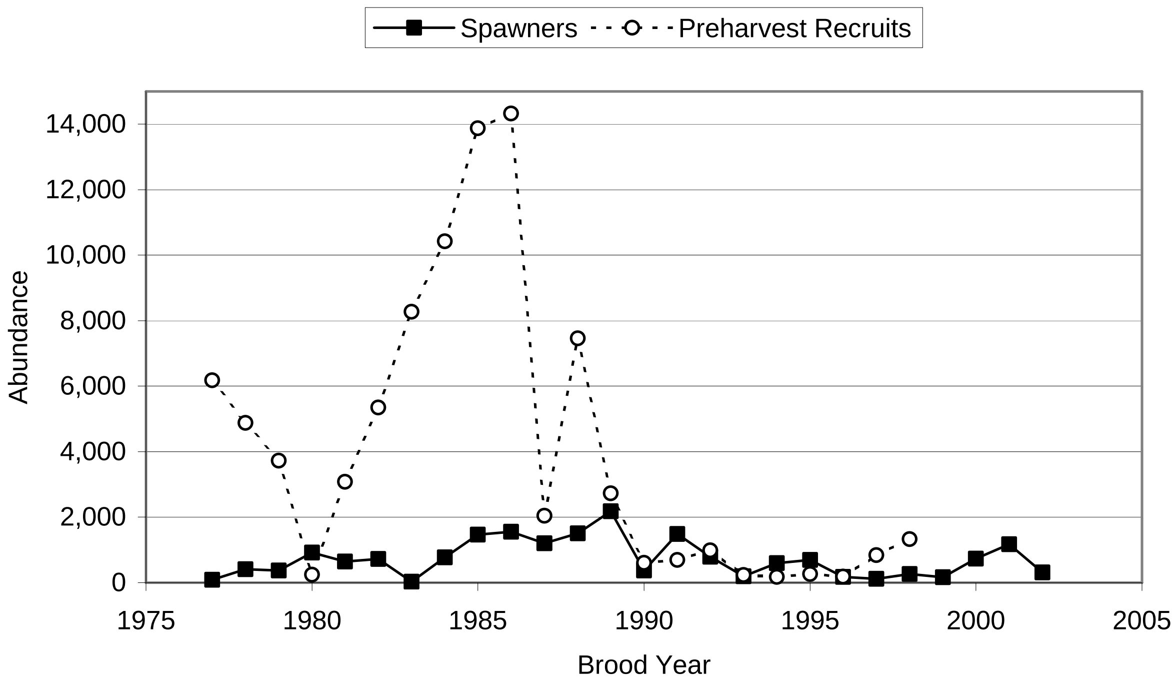

Figure C.2.4.10. Estimate of pre-harvest coho salmon recruits and spawners in the Sandy River. Based on adult counts at Marmot Dam.

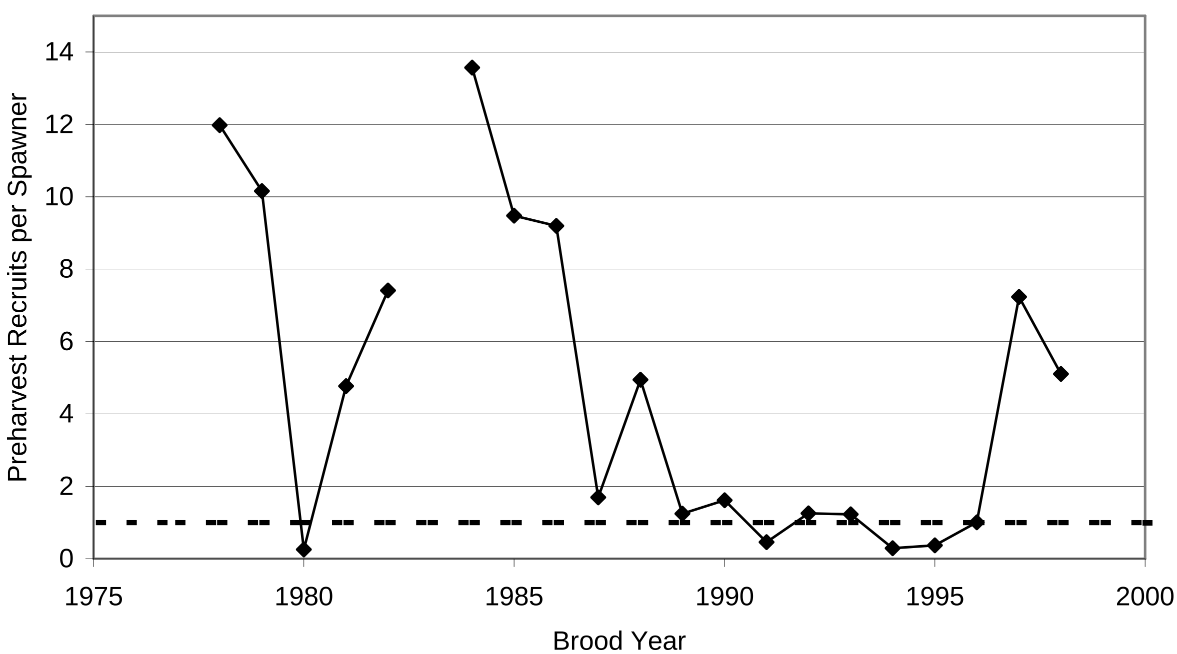

Figure C.2.4.11. Estimate of pre-harvest coho salmon recruits-per-spawners in the Sandy River. Based on adult counts at Marmot Dam. The dashed line indicates the replacement level. The 1977 brood-year pre-harvest recruits-per-spawner estimate is 68 and the 1983 brood-year estimate is 318.

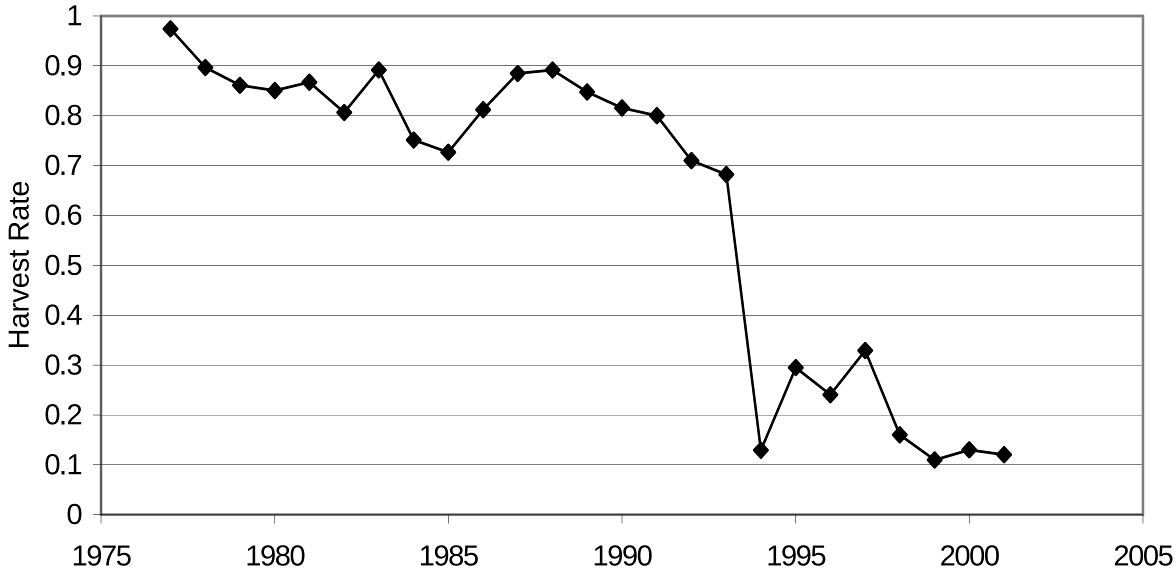

Figure C.2.4.12. Sandy River natural-origin coho salmon harvest rate (M. Chilcote, pers. comm.). The reduction in harvest rate was achieved by switch to retention only marked hatchery fish and timing the fishery to protect natural runs.

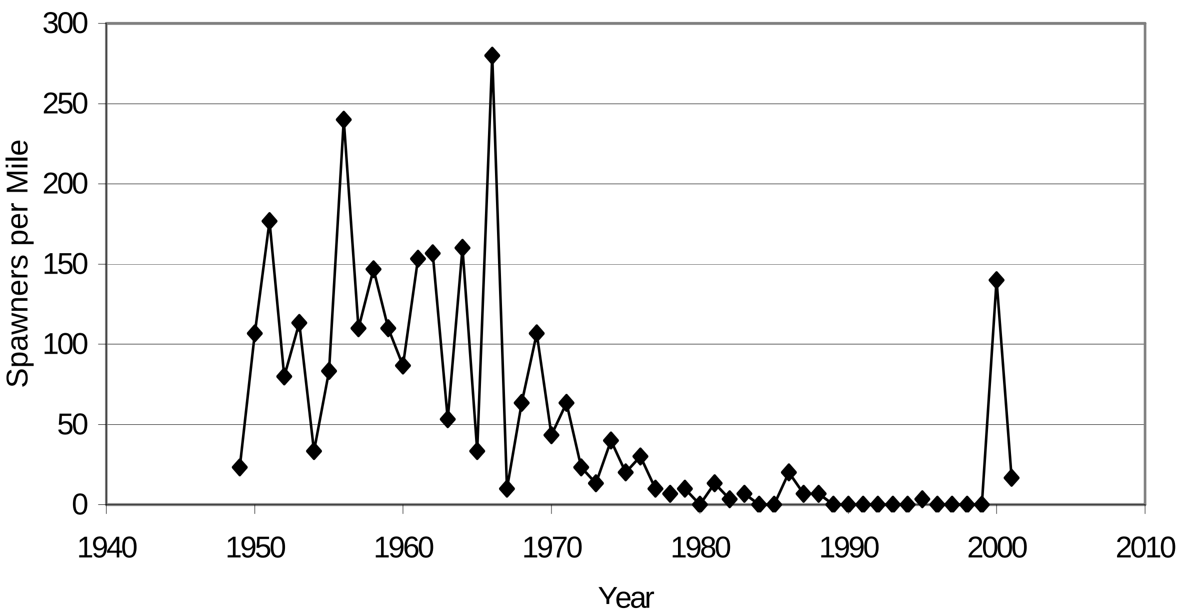

Figure C.2.4.13. Youngs Bay coho salmon spawners-per-mile.

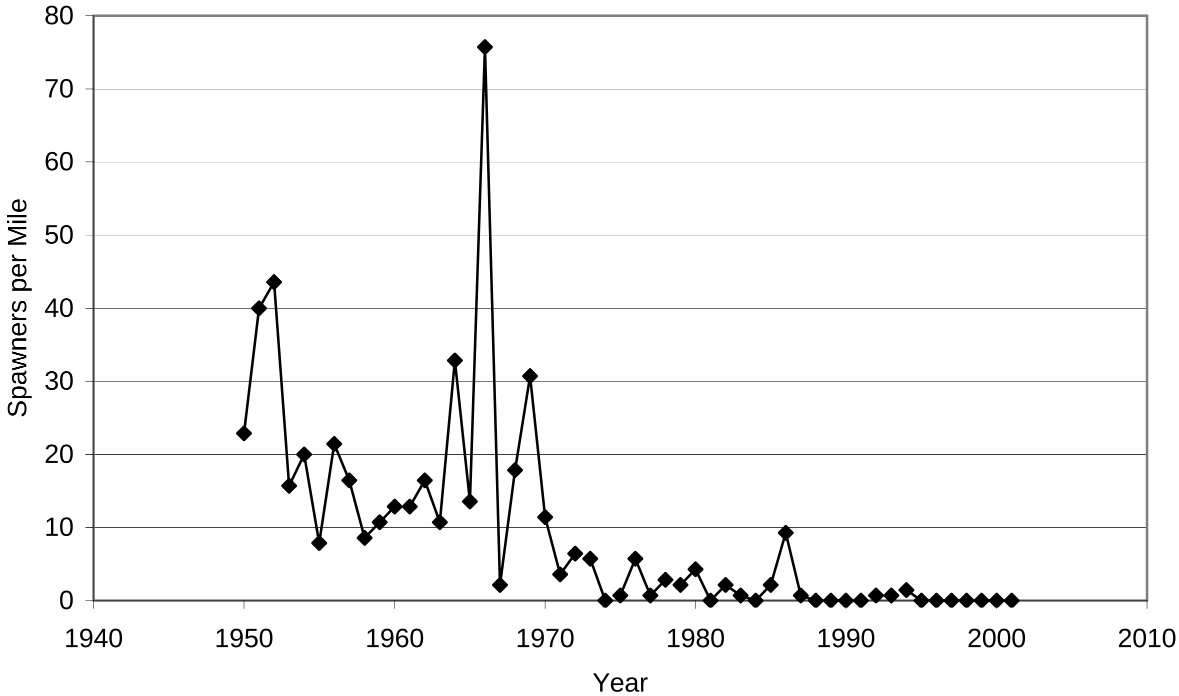

Figure C.2.4.14. Big Creek coho salmon spawners-per-mile.

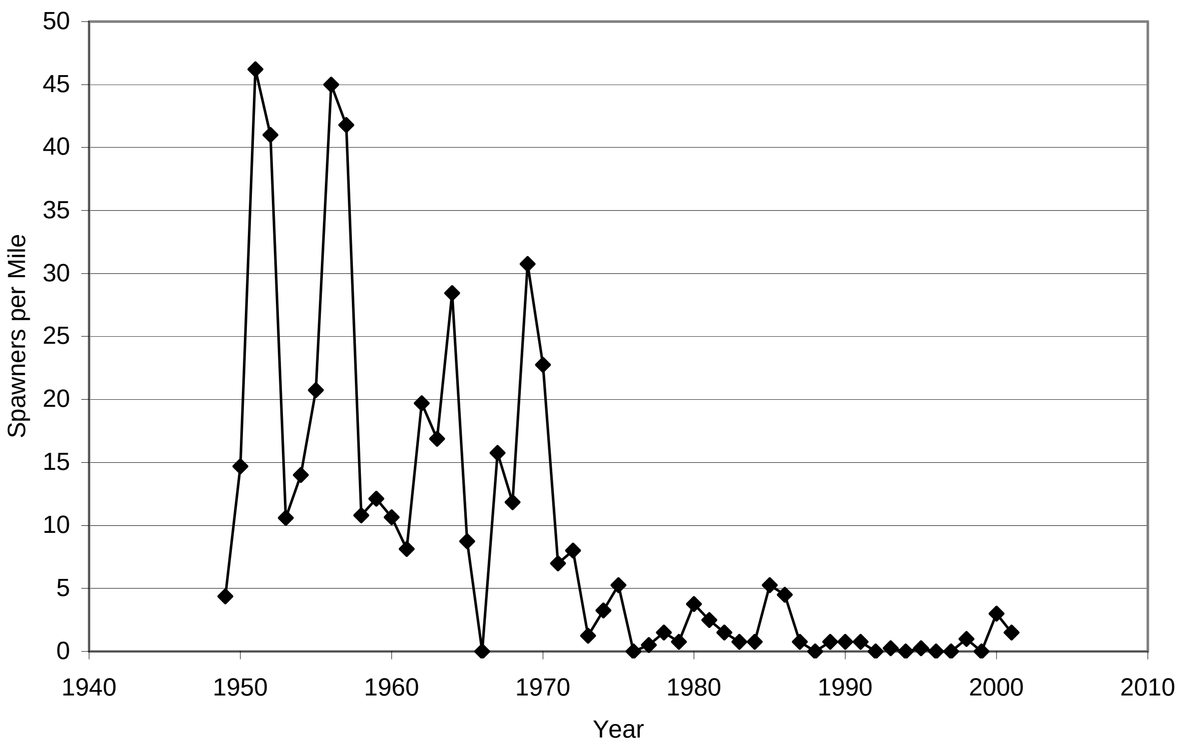

Figure C.2.4.15. Clatskanie River coho salmon spawners-per-mile.

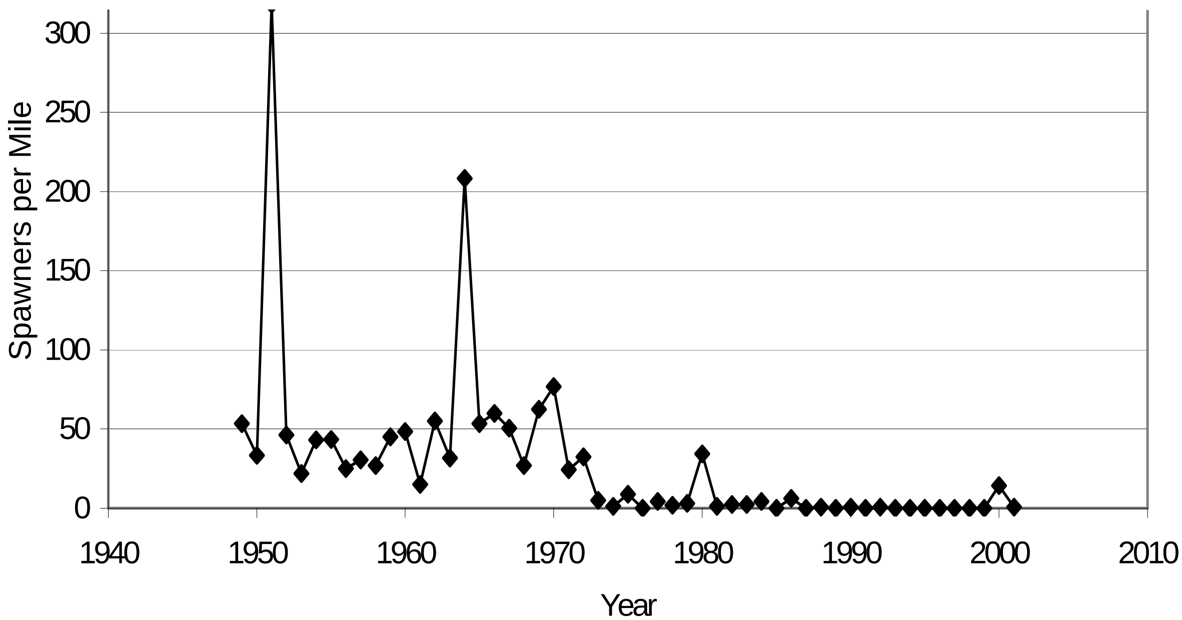

Figure C.2.4.16. Scappoose River spawners-per-mile.

C.3 COHO SALMON BRT CONCLUSIONS

Oregon Coast coho salmon ESU

This ESU continues to present challenges to those assessing extinction risk. The BRT found several positive features compared to the previous assessment in 1997. Adult spawners for the ESU in 2001 and 2002 exceeded the number observed for any year in the past several decades, and pre-harvest run size rivaled some of the high values seen in the 1970s. Some notable increases in spawners have occurred in many streams in the northern part of the ESU, which was the most depressed area at the time of the last status review evaluation. Hatchery reforms have continued, and the fraction of natural spawners that are first-generation hatchery fish has been reduced in many areas compared to highs in the early to mid 1990s.

On the other hand, the recent years of good returns were preceded by three years of low spawner escapements—the result of three consecutive years of recruitment failure, in which the natural spawners did not replace themselves the next generation, even in the absence of any directed harvest. These three years of recruitment failure, which immediately followed the last status review in 1997, are the only such instances that have been observed in the entire time series of data collected for Oregon Coast coho salmon. Whereas the recent increases in spawner escapement have resulted in long-term trends in spawners that are generally positive, the long-term trends in productivity in this ESU are still strongly negative.

The BRT votes reflected ongoing concerns for the long-term health of this ESU: a majority (56%) of the FEMAT votes were cast in the "likely to become endangered" category, with a substantial minority (44%) falling in the "not likely to become endangered" category (Table C.3.1). Although the BRT considered the significantly higher returns in recent years to be encouraging, most members felt that the factors responsible for the increases were more likely to be unusually favorable marine productivity conditions than improvements in freshwater productivity. The majority of BRT members felt that to have a high degree of confidence that the ESU is healthy, high spawner escapements should be maintained for a number of years, and the freshwater habitat should demonstrate the capability of supporting high juvenile production from years of high spawner abundance. As indicated in the risk matrix results, the BRT considered the decline in productivity to be the most serious concern for this ESU (mean score 3.2; Table C.3.2). With all directed harvest for these populations already eliminated, harvest management can no longer compensate for declining productivity by reducing harvest rates. The BRT was concerned that if the long-term decline in productivity reflects deteriorating conditions in freshwater habitat, this ESU could face very serious risks of local extinctions during the next cycle of poor ocean conditions. With the cushion provided by strong returns in the last 2-3 years, the BRT had much less concern about short-term risks associated with abundance (mean score 1.9).

A minority of the BRT felt that the large number of spawners in the last few years demonstrate that this ESU is not currently at significant risk of extinction or likely to become endangered. Furthermore, these members felt that the recent years of high escapement, following closely on the heels of the years of recruitment failure, demonstrate that populations in this ESU have the resilience to bounce back from years of depressed runs.

Southern Oregon/Northern California Coasts coho salmon ESU

A majority (67%) of BRT votes fell into the "likely to become endangered" category, while votes in the "endangered" category outnumbered those in the "not warranted" categories by 2-to-1 (Table C.3.1). The BRT found moderately high risks for abundance and growth rate/production, with mean matrix scores of 3.5 to 3.8, respectively, for these two categories. Risks to spatial structure (mean score = 3.1) and diversity (mean score = 2.8) were considered moderate by the BRT (Table C.3.2).

The BRT remained concerned about low population abundance throughout the ESU relative to historical numbers and long-term downward trends in abundance; however, the paucity of data on escapement of naturally produced spawners in most basins continued to hinder assessment of risk. A reliable time series of adult abundance is available only for the Rogue River. These data indicate that long-term (22-year) and short-term (10-year) trends in mean spawner abundance are upward in the Rogue; however, the positive trends reflect effects of reduced harvest (rather than improved freshwater conditions) since trends in pre-harvest recruits are flat. Less-reliable indices of spawner abundance in several California populations reveal no apparent trends in some populations and suggest possible continued declines in others. Additionally, the BRT considered the relatively low occupancy rates of historical coho salmon streams (between 37% and 61% from broodyear 1986 to 2000) as an indication of continued low abundance in the California portion of this ESU. The relatively strong 2001 broodyear, likely the result of favorable conditions in both freshwater and marine environments, was viewed as a positive sign, but was a single strong year following more than a decade of generally poor years.

The moderate risk matrix scores for spatial structure reflected a balancing of several factors. On the negative side was the modest percentage of historical streams still occupied by coho salmon (suggestive of local extirpations or depressed populations). The BRT also remains concerned about the possibility that losses of local populations have been masked in basins with high hatchery output, including the Trinity, Klamath, and Rogue systems. The extent to which strays from hatcheries in these systems are contributing to natural production remains uncertain; however, it is generally believed that hatchery fish and progeny of hatchery fish constitute the majority of production in the Trinity River, and may be a significant concern in parts of the Klamath and Rogue systems a well. On the positive side, extant populations can still be found in all major river basins within the ESU. Additionally, the relatively high occupancy rate of historical streams observed in broodyear 2001 suggests that much habitat remains accessible to coho salmon. The BRT's concern for the large number of hatchery fish in the Rogue, Klamath, and Trinity systems was also evident in the moderate risk rating for diversity.

Central California coho salmon ESU

A large majority (74%) of the BRT votes fell into the "endangered" category, with the remainder falling into the "likely to become endangered" category (Table C.3.1). The BRT found CCC coho salmon to be at very high risk in three of four risk categories, with mean scores of 4.8, 4.5, and 4.7 for abundance, growth rate/productivity, and spatial structure, respectively (Table C.3.2). Scores for diversity (mean 3.6) indicated BRT members considered CCC coho salmon to be at moderate or increasing risk with respect to this risk category. Principal concerns of the BRT continue to be low abundance and long-term downward trends in abundance of coho salmon throughout the ESU, as well as extirpation or near extirpation of populations across most of the southern two-thirds of the historical range of the ESU, including several major river basins. Potential loss of genetic diversity associated with range reductions or loss of one or more brood lineages, coupled with historical influence of hatchery fish, were primary risks to diversity identified by the BRT. Improved oceanic conditions coupled with favorable stream flows apparently contributed to a strong year class in broodyear 2001, as evidenced by an increase in detected occupancy of historical streams. However, data were lacking for many river basins in the southern two-thirds of the ESU where populations are considered at greatest risk. Although viewed as a positive sign, the strong year follows more than a decade of relatively poor returns. The lack of current estimates of naturally produced spawners for any populations within the ESU—and hence the need to use primarily presence-absence information to assess risk—continues to concern the BRT.

Lower Columbia River coho salmon ESU

The status of this ESU was reviewed by the BRT in 2000, so relatively little new information was available. A majority (68%) of the likelihood votes for Lower Columbia River coho salmon fell in the "danger of extinction" category, with the remainder falling in the "likely to become endangered" category (Table C.3.1). As indicated by the risk matrix totals (Table C.3.2), the BRT had major concerns for this ESU in all VSP risk categories (mean scores ranged from 4.2 for spatial structure/connectivity and growth rate/productivity to 4.5 for diversity). The most serious overall concern was the scarcity of naturally produced spawners throughout the ESU, with attendant risks associated with small population, loss of diversity, and fragmentation and isolation of the remaining naturally produced fish. In the only two populations with significant natural production (Sandy and Clackamas), short and long-term trends are negative and productivity (as gauged by preharvest recruits) is down sharply from recent (1980s) levels. On the positive side, adult returns in 2000 and 2001 were up noticeably in some areas, and evidence for limited natural production has been found in some areas outside the Sandy and Clackamas.

The paucity of naturally produced spawners in this ESU can be contrasted with the very large number of hatchery-produced adults. Although the scale of the hatchery programs, and the great disparity in relative numbers of hatchery and wild fish, produce many genetic and ecological threats to the natural populations, collectively these hatchery populations contain a great deal of genetic resources that might be tapped to help promote restoration of more widespread naturally spawning populations.

Table C.3.1. Tally of FEMAT vote distribution regarding the status of 4 coho salmon ESUs reviewed by the coho salmon BRT. Each of 13 BRT members allocated 10 points among the three status categories.

ESU	Danger of Extinction	Likely to Become Endangered	Not Likely to Become Endangered
Oregon Coast	0	73	57
S. Oregon / N. California Coasts	29	87	14
Central California	96	34	0
Lower Columbia River	88	42	0

Table C.3.2. Summary of risk scores (1 = low to 5 = high) for four VSP categories (see section "Factors Considered in Status Assessments" for a description of the risk categories) for the 4 coho salmon ESUs reviewed. Data presented are means (range).

ESU	Abundance	Growth Rate/Productivity	Spatial Structure and Connectivity	Diversity
Oregon Coast	1.9 (1-3)	3.2 (2-4)	2.3 (1-3)	2.5 (2-3)
S. Oregon / N. California Coasts	3.8 (2-5)	3.5 (2-5)	3.1 (2-4)	2.8 (2-4)
Central California	4.8 (4-5)	4.5 (4-5)	4.7 (4-5)	3.6 (2-5)
Lower Columbia River	4.4 (4-5)	4.2 (3-5)	4.2 (2-5)	4.5 (4-5)

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C.5 APPENDICES

Appendix C.5.1. Preliminary SSHAG (2003) categorizations of hatchery populations of the four coho salmon ESUs reviewed. See "Artificial Propagation" in General Introduction for explanation of the categories.

	Stock	Run	Basin	SSHAG Category
Oregon Coast	NF Nehalem	(# 32)	Nehalem	2c
	Fishhawk Lake	(# 99)	Nehalem	2a or 3a
	Trask River	(# 34)	Trask	2c or 3c
	Siletz	(# 33)	Siletz	2a or 3a
	Umpqua	(# 55)	Umpqua	2a
	Cow Creek	(# 18)	Umpqua	2a
	Woahink		Siltcoos	1a
	Coos	(# 37)	Coos	2a
	Coquille	(# 44)	Coquille	2a
S. Oregon/N. California Coasts	Rogue River	(# 52)	Rogue River	2a
	Iron Gate		Klamath	2c
	Trinity River		Trinity	2b
	Mad River		Mad River	4
Central California	Noyo River		Noyo River	2a
	Don Clausen		Russian	1a
	Monterey Bay		Scott Creek	1a
Lower Columbia River	Big Creek		Big Creek	2a
	Klaskanine		Klaskanine	4
	Tanner Creek		Lower Gorge	2b
	Sandy River	late	Sandy	2a
	Eagle Creek		Clackamas	2c
	Little White Salmon		Upper Gorge	3c
	Toutle	Type S	Cowlitz	2a
	Type S Complex	Type S	various	2c or 3c

	Cowlitz	Type N	Cowlitz	2a
	Type N Complex	Type N	various	2b o 2c

Appendix C.5.2. Coho Salmon Time Series Data Sources

Oregon Coast coho salmon ESU

Population	Oregon Coast
Years of Data, Length of Series	1970-2002, 33 years
Abundance Type	Fish
Abundance References	Jacobs et al., 2000, Jacobs et al. 2001, Jacobs et al. 2002, PFMC 2002a, PFMC 2003.
Abundance Notes	Rivers: 1970-1989 index live spawner surveys expanded by stream miles. 1990-2002 stratified random sample (SRS) survey design. Pre-1990 calibrated to SRS estimates. Lakes: index surveys expanded by historical mark-recapture data.

Southern Oregon/Northern California Coasts coho salmon ESU

Population	Rogue River
Years of Data, Length of Series	[see figure captions]
Abundance Type	Adult Fish
Abundance References	[See figure captions]
Abundance Notes	Abundance estimates based on expansion of beach seine abundance index based on hatchery fraction and returns of hatchery fish to Cole Rivers hatchery.

Populations	Hollow Tree Creek (Mendocino Co.)
Years of Data; Length of Series	1986-2002 (1983 included for one site; 1992 excluded from one site); 16-18 years
Abundance Type	Juvenile density estimates (index reaches)
Data Sources	Electronic files provided Scott Harris, CDFG, based on data collected by Scott Harris and Wendy Jones (CDFG retired)
Abundance Notes	Juvenile density estimates are derived based on multiple-pass depletion estimates at index reaches established by CDFG.

Populations	South Fork Eel River basin (5 sites) (Mendocino Co.)
Years of Data; Length of Series	1994-2002 for one site, 1995-2002 for all others; 8-9 years
Abundance Type	Juvenile density estimates (index reaches)
Data Sources	Electronic files provided David Wright and Stephen Levesque, Campbell Timberland Management, Fort Bragg, CA.

Abundance Notes	Juvenile density estimates are derived based on multiple-pass depletion estimates at index reaches established by Campbell Timberland Management. Most index reaches range from approximately 30 to 60 m in length.

Populations	Numerous throughout SONCC ESU
Years of Data; Length of Series	Variable, extending back to 1987.
Data Type	Presence-absence observations
Data Sources	Electronic database developed by NMFS SWFSC augmented with data provided by Bill Jong and Larry Preston, CDFG.
Data Notes	Database contains information on coho salmon occurrence in streams throughout the SONCC ESU. Original sources include a variety of surveys, reports, and other documents produced by CDFG, NMFS, tribes, private landowners, academic institutions, and others doing research or monitoring of coho salmon or other salmonids in streams believed to have historically supported coho salmon. Original sources are documented in databases housed at the NMFS SWFSC.

Central California Coast coho salmon ESU

Populations	Caspar Creek and Little River (Mendocino Co.)
Years of Data, Length of Series	1987-2002; 16 years
Abundance Type	Smolt counts (partial)
Data Source	Electronic files provided Scott Harris, CDFG, based on data collected by Scott Harris and Wendy Jones (CDFG retired)
Abundance Notes	Smolt counts are partial counts made at downstream migrant traps and are not corrected for trap efficiency; numbers should be viewed as indices of abundance rather than population estimates

Population	Noyo River Egg Collecting Station (Mendocino Co.)
Years of Data, Length of Series	1962-2001; 40 years
Abundance Type	Adult counts (partial)
Data Source	Grass 2002
Abundance Notes	Counts of adult coho salmon are partial counts made at the Noyo Egg Collecting Station on the South Fork of the Noyo River. In most years, the trap was not operated continuously during the spawning season. Furthermore, trapping usually ceased when egg take goals were met. Thus, counts should be viewed as indices of abundance rather than population estimates

Populations	Pudding Creek, Caspar Creek, and Little River (Mendocino Co.)
Years of Data; Length of Series	Pudding Creek: 1983-2002 (except 1990); 19 years

	Caspar Creek (2 sites): 1986-2002; 17 years Little River (2 sites): 1986-2002 (except 2000); 16 years
Abundance Type	Juvenile density estimates (index reaches)
Data Sources	Electronic files provided Scott Harris, CDFG, based on data collected by Scott Harris and Wendy Jones (CDFG retired)
Abundance Notes	Juvenile density estimates are derived based on multiple-pass depletion estimates at index reaches established by CDFG. Pudding Creek site has been sampled in recent years by Campbell Timberland Management.

Populations	Noyo River, Big River, and Big Salmon Creek (Mendocino Co.)
Years of Data; Length of Series	Noyo River (8 sites): generally 1993-2002 (variable among sites); 6-10 years Big River (2 sites): 1993-2002; 10 years Big Salmon Creek (5 sites): generally 1993-2002 (variable among sites); 7-10 years
Abundance Type	Juvenile density estimates (index reaches)
Data Sources	Electronic files provided David Wright and Stephen Levesque, Campbell Timberland Management, Fort Bragg, CA.
Abundance Notes	Juvenile density estimates are derived based on multiple-pass depletion estimates at index reaches established by Campbell Timberland Management. Most index reaches range from approximately 30 to 60 m in length.

Populations	Lagunitas Creek (Marin Co.)
Years of Data; Length of Series	1995-2001; 7 years
Abundance Type	Juvenile population estimates (expanded from index reaches)
Data Sources	Electronic files provided Eric Ettlinger, Marin Municipal Water District.
Abundance Notes	Juvenile density estimates for different habitat unit types are derived based on multiple-pass depletion estimates at index reaches. Unit-specific density estimates are then used in conjunction with habitat typing for the entire stream reach to obtain an overall population estimate for juveniles within the stream.

Population	Redwood Creek (Marin Co.)
Years of Data; Length of Series	1994-2001 (excluding 1999); 7 years
Abundance Type	Juvenile population index
Data Sources	Smith 1994-2001.

Abundance Notes	Juvenile counts are made annually at multiple index sites in Redwood Creek using single-pass electrofishing. Mean numbers of fish per linear distance of stream were calculated based only on sites that were sampled each year during the period of record (i.e., sites sampled sporadically were not included in the overall estimate).

Populations	Waddell and Scott Creek (Santa Cruz Co.), and Gazos Creek (San Mateo Co.)
Years of Data; Length of Series	Waddell Creek and Scott Creek, 1992-2001; 10 years Gazos Creek, 1993-2001 (excluding 1994); 8 years
Abundance Type	Juvenile population index
Data Sources	Smith 1992-2001.
Abundance Notes	Juvenile counts are made annually at multiple index sites in each creek using single-pass electrofishing. Mean numbers of fish per linear distance of stream were calculated based only on sites that were sampled each year during the period of record (i.e., sites sampled sporadically were not included in the overall estimate).

Populations	Numerous throughout Central California Coast ESU
Years of Data; Length of Series	Variable, extending back to 1987.
Data Type	Presence-absence observations
Data Sources	Electronic database developed by NMFS SWFSC augmented with data from the Russian River basin provided by Bob Coey, CDFG.
Data Notes	Database contains information on coho salmon occurrence in streams throughout the CCC ESU. Original sources include a variety of surveys, reports, and other documents produced by CDFG, NMFS, private landowners, water districts, academic institutions, and others doing research or monitoring of coho salmon or other salmonids in streams believed to have historically supported coho salmon. Original sources are documented in databases housed at the NMFS SWFSC.

Lower Columbia River coho salmon ESU

Population	Clatskanie River
Years of Data, Length of Series	1949 - 2001, 53 years
Abundance Type	Fish per mile
Abundance References	Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J.. 1998; White, E., Morgan, B. and Fulop, J. 1999; Ollerenshaw, E. 2002.
Abundance Notes	Data from Streamnet

Population	Scappoose Creek

Years of Data, Length of Series	1949 - 2001, 53 years
Abundance Type	Fish per mile
Abundance References	Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J.. 1998; White, E., Morgan, B. and Fulop, J. 1999; Ollerenshaw, E. 2002
Abundance Notes	Data from Streamnet

Population	Big Creek
Years of Data, Length of Series	1950 - 2001, 52 years
Abundance Type	Fish per mile
Abundance References	Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J. 1998; White, E., Morgan, B. and Fulop, J. 1999; Ollerenshaw, E. 2002.
Abundance Notes	Data from Streamnet

Population	Clackamas River
Years of Data, Length of Series	1950 - 2001, 52 years
Abundance Type	Fish per mile
Abundance References	Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J. 1998; White, E., Morgan, B. and Fulop, J.. 1999; Ollerenshaw, E. 2002
Abundance Notes	Data from Streamnet

Population	Youngs Bay
Years of Data, Length of Series	1949 - 2001, 53 years
Abundance Type	Fish per mile
Abundance References	Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J. 1998; White, E., Morgan, B. and Fulop, J.. 1999; Ollerenshaw, E. 2002
Abundance Notes	Data from Streamnet

Population	Sandy River (Marmot Dam)
Years of Data, Length of Series	1977 - 2001, 25 years
Abundance Type	Dam count
Abundance References	Cramer 2002

Population	Clackamas River (North Fork Dam)
Years of Data, Length of Series	1957 - 2001, 45 years
Abundance Type	Dam count
Abundance References	Cramer 2002